African Invertebrates 59(2): 195–237 (2018)
doi: 10.3897/AfrInvertebr.59.30684
http://africaninvertebrates.pensoft.net

RESEARCH ARTICLE

African Invertebrates
A journal of biodiversity research

Taxonomic revision of the assassin-fly genus *Microphontes* Londt, 1994 (Insecta, Diptera, Asilidae)

Amanda Markee[1], Torsten Dikow[2]

1 *New College of Florida, 5800 Bay Shore Rd, Sarasota, FL 34243, USA* **2** *Department of Entomology, National Museum of Natural History, Smithsonian Institution, 10th Street and Constitution Avenue NW, Washington, DC 20560, USA*

Corresponding author: *Torsten Dikow* (DikowT@si.edu)

Academic editor: *B. Muller* | Received 19 October 2018 | Accepted 8 November 2018 | Published 30 November 2018

http://zoobank.org/0F2906F5-DE06-4F15-BA2B-69BDD7D2AAF1

Citation: Markee A, Dikow T (2018) Taxonomic revision of the assassin-fly genus *Microphontes* Londt, 1994 (Insecta, Diptera, Asilidae). African Invertebrates 59(2): 195–237. https://doi.org/10.3897/AfrInvertebr.59.30684

Abstract

The genus *Microphontes* Londt, 1994 (Diptera: Asilidae: Brachyrhopalinae) is revised. Currently, three species are known from Namibia and western South Africa, i.e. *Microphontes megoura* Londt, 1994 from north-western South Africa, *Microphontes safra* Londt, 1994 from Namibia and *Microphontes whittingtoni* Londt, 1994 from western South Africa. Four new species, *Microphontes ericfisheri* **sp. n.** from the Little Karoo of South Africa, *Microphontes gaiophanes* **sp. n.** from the Namib desert of Namibia and *Microphontes jasonlondti* **sp. n.** and *Microphontes kryphios* **sp. n.** from western South Africa, are described. Distribution, occurrence in biodiversity hotspots sensu Conservation International and seasonal incidence are discussed. Descriptions/redescriptions, photographs and identification keys are provided and made openly accessible in data repositories to support future studies of the included taxa. An unusual flight pattern of male *Microphontes gaiophanes* **sp. n.** is discussed. A unique morphological feature on tergite 8 of *Microphontes* females, termed postero-paramedian T8 pores, is described, illustrated and discussed.

Keywords

Assassin fly, robber fly, cybertaxonomy, open-access, male flight behaviour, female postero-paramedian T8 pores

Copyright *Amanda Markee, Torsten Dikow*. This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Introduction

Microphontes Londt, 1994 is endemic to Namibia and western South Africa (Londt 1994) and flies inhabit sandy habitats along rivers or on sand dunes (Figs 1–4). *Microphontes* was initially based on three species known from 18 specimens, i.e. *Microphontes megoura* Londt, 1994 from north-western South Africa, *Microphontes safra* Londt, 1994 from Namibia and *Microphontes whittingtoni* Londt, 1994 from western South Africa (Fig. 5). It had not been studied in any detail since then and was only included in updated identification keys to the Afrotropical Stenopogoninae by Londt (2013) and Asilidae by Londt and Dikow (2017) and in reference to the description of the genus *Antiscylaticus* Londt, 2010 from western Africa (Londt 2010).

Recently, specimens of a small assassin-fly species belonging to *Microphontes* were collected by the junior author on sand dunes on the eastern edge of the Namib Desert in Namibia (Figs 1–2) and that initiated a closer look at this genus. Furthermore, specimens had accumulated in natural history collections that extended the range and are here recorded for the first time (Fig. 5).

We present a taxonomic revision of *Microphontes* based on 44 specimens from 14 collecting events in desert to semi-desert localities in western South Africa and Namibia and describe four new species.

Material and methods

Morphological features were examined using a Leica MZ8 with LED goose-neck lights and a Zeiss SteREO Discovery.V12 stereo microscope with an LED ring-light. Wing length is measured from the tegula to the distal tip of the wing. The female and male terminalia were first excised and macerated in 10% potassium hydroxide (KOH) at 55 °C followed by neutralisation in acetic acid (glacial, CH_3COOH) and rinsing in distilled water (H_2O). They were temporarily stored in 75% ethanol (C_2H_5OH) for examination and illustration and sealed in polyethylene vials containing 100% glycerine (C_3H_8O) and attached to the specimen's pin.

Terminology

Terminology follows Dikow (2009), Cumming and Wood (2017) and Londt and Dikow (2017) (general morphology and abbreviations for setae), Stuckenberg (1999) (antennae) and Wootton and Ennos (1989) (wing venation). Abdominal tergites are abbreviated in the descriptions with 'T' and sternites are abbreviated with 'S'. The terms prothoracic, mesothoracic and metathoracic are abbreviated 'pro', 'mes' and 'met', respectively. The term pubescence (adjective pubescent) refers to the short, fine microtrichia densely covering certain body parts. Other generalised terms follow the Torre-Bueno Glossary of Entomology (Nichols 1989).

Species descriptions and re-descriptions

Species descriptions are based on composites of all specimens and not exclusively on the holotype and are compiled from a character matrix of 218 features and 359 character states assembled with Lucid Builder (version 3.5) and exported as natural-language descriptions. These species descriptions have been deposited in the Zenodo data repository and can be accessed in XML-format following the SDD (Structure of Descriptive Data) standard. The structure of wings and terminalia is only described once for the genus (with a few exceptional characteristics) and additional species-specific features should be interpreted from the provided photographs. The description of the pubescence pattern, particularly of the abdomen, is based on the examination of the specimens with an LED ring-light while the photographs were taken with a twin-flash (more similar to the lighting with two goose-neck lights). Care needs to be taken to study the pattern in both dorsal and lateral view. All taxon names have been registered in ZooBank (Pyle and Michel 2008).

Figures 1–4. Habitat photographs: **1–2** sparsely vegetated sand dune on the eastern edge of the Namib Sand Sea N of Solitaire, Namibia (23°34'22"S, 015°48'37"E) where *Microphontes gaiophanes* sp. n. was collected **3–4** slope of Elim Dune with *Stipagostris* sp. (Poaceae) on the eastern edge of the Namib Sand Sea W of Sesriem, Namibia (24°27'28"S, 015°46'37"E) where *M. safra* was collected. Photographs by T. Dikow.

Specimen occurrence data

Specimen occurrence data were captured in a custom FileMaker Pro database and the following data are exported and presented for each specimen (where available): country, state/province, county, locality, geographic co-ordinates (formatted in both degrees minutes seconds and decimal latitude/longitude), elevation (in metres), date of collection (format: yyyy-mm-dd), habitat information, perching behaviour, sampling protocol (if other than hand netting), collector, catalogue number (a unique specimen identifier and any other identifying number), depository (institution code), number of specimens and sex. Each specimen is listed with a unique specimen identifier (either an institutional catalogue number or an AAM-XXXXXX number used by the junior author) that will allow the re-investigation as well as provide a unique Life Science Identifier (LSID). The occurrence of all species is illustrated in distribution maps plotted with SimpleMappr with all of those localities for which co-ordinates are available. Type localities are plotted with a square symbol while all other specimens are plotted with a circular symbol. The distribution map includes Biodiversity Hotspots sensu Conservation International (Mittermeier et al. 1998; Myers et al. 2000; Mittermeier et al. 2005). The specimen occurrence data are deposited as a Darwin Core Archive (DwC-A) in the Global Biodiversity Information Facility (GBIF) using the Integrated Publishing Toolkit (IPT) at the NMNH.

Photographs

Whole habitus photographs of pinned specimens were taken using a GIGAmacro Magnify^2 (http://www.gigamacro.com/gigapixel-macro-imaging-system/) system, a Canon EOS D5 full-frame DSLR, a Canon MP-E 65 mm f2.8 macro-lens and illuminated by a twin-flash. Individual RAW format images were stacked using HeliconFocus Pro (version 6.7.1) utilising Method C (pyramid) and exported in Adobe DNG-format. In some instances, greasy specimens were placed in acetone ($(CH_3)_2CO$) for 24–48 hours for degreasing to enhance the study of pubescence and image quality (see, e.g. Figs 36–37).

Detailed photographs of morphological features were taken using a Zeiss STEREO Discovery.V8 stereo microscope, a Zeiss PlanApo S 1.5× lens, illuminated with visiLED ring-lights and a transillumination base and an attached Olympus OM-D E-M1 Micro Four Thirds camera. Individual RAW-format images were stacked using Affinity Photo with default settings.

All photographs have been deposited in Morphbank Biological Imaging. These images will be automatically harvested by the Encyclopedia of Life (EOL) and are available under the respective species page.

Key

The dichotomous, interactive key has been built with Lucid Phoenix and can be accessed on Lucidcentral and the junior author's research web-site.

Institutions providing specimens

Institutions providing specimens are listed below, together with the abbreviations used in the text when citing depositories (institutionCode) and the people who kindly assisted: INHS Illinois Natural History Survey, Urbana-Champaign, IL, USA (Thomas McElrath); NMSA KwaZulu-Natal Museum, Pietermaritzburg, South Africa (Tricia Pillay); NMNW National Museum of Namibia, Windhoek, Namibia; SAMC Iziko South African Museum, Cape Town, South Africa (Aisha Mayekiso); USNM National Museum of Natural History, Smithsonian Institution, Washington, DC, USA; ZMUC Natural History Museum of Denmark, Copenhagen, Denmark (Thomas Pape).

Data resources

GBIF:	specimen occurrence data-set – https://www.gbif.org/dataset/4c13483d-a2ac-4c61-9087-c4e1a3c7b91d, https://doi.org/10.15468/m2vwyh
Lucid Phoenix:	illustrated, dichotomous identification key – http://keys.lucidcentral.org/keys/phoenix/microphontes/
Morphbank:	imagecollectionID – http://www.morphbank.net/myCollection/?id=861475
SimpleMappr:	distribution maps – as in Fig. 5 10597 – Google Earth KML file 10597 – as in Fig. 71 10598 – KML file 10598 – as in Fig. 72 10599 – KML file 10599.
Zenodo:	natural-language species descriptions from Lucid Builder in SDD format – DOI http://dx.doi.org/10.5281/zenodo.1466156
ZooBank:	nomenclatorial acts – http://zoobank.org/0F2906F5-DE06-4F15-BA2B-69BDD7D2AAF1

Taxonomy

Microphontes Londt, 1994

http://zoobank.org/4AE2ACF4-F13B-4BE5-A4CA-4EBCB4916620

Microphontes Londt, 1994: 86. Type-species: *Microphontes whittingtoni* Londt, 1994, by original designation.

Diagnosis. The genus can be delineated by its small size with a wing length of only 3.0–5.5 mm, mystacal setae restricted to the lower facial margin, at least weakly macrosetose ante- and postpronotum, short to long setose dorsal anepisternum, male terminalia rotated by 90–180°, short or long postero-median projection on the hypandrium of males and presence of postero-paramedian pores on abdominal tergite 8 in females.

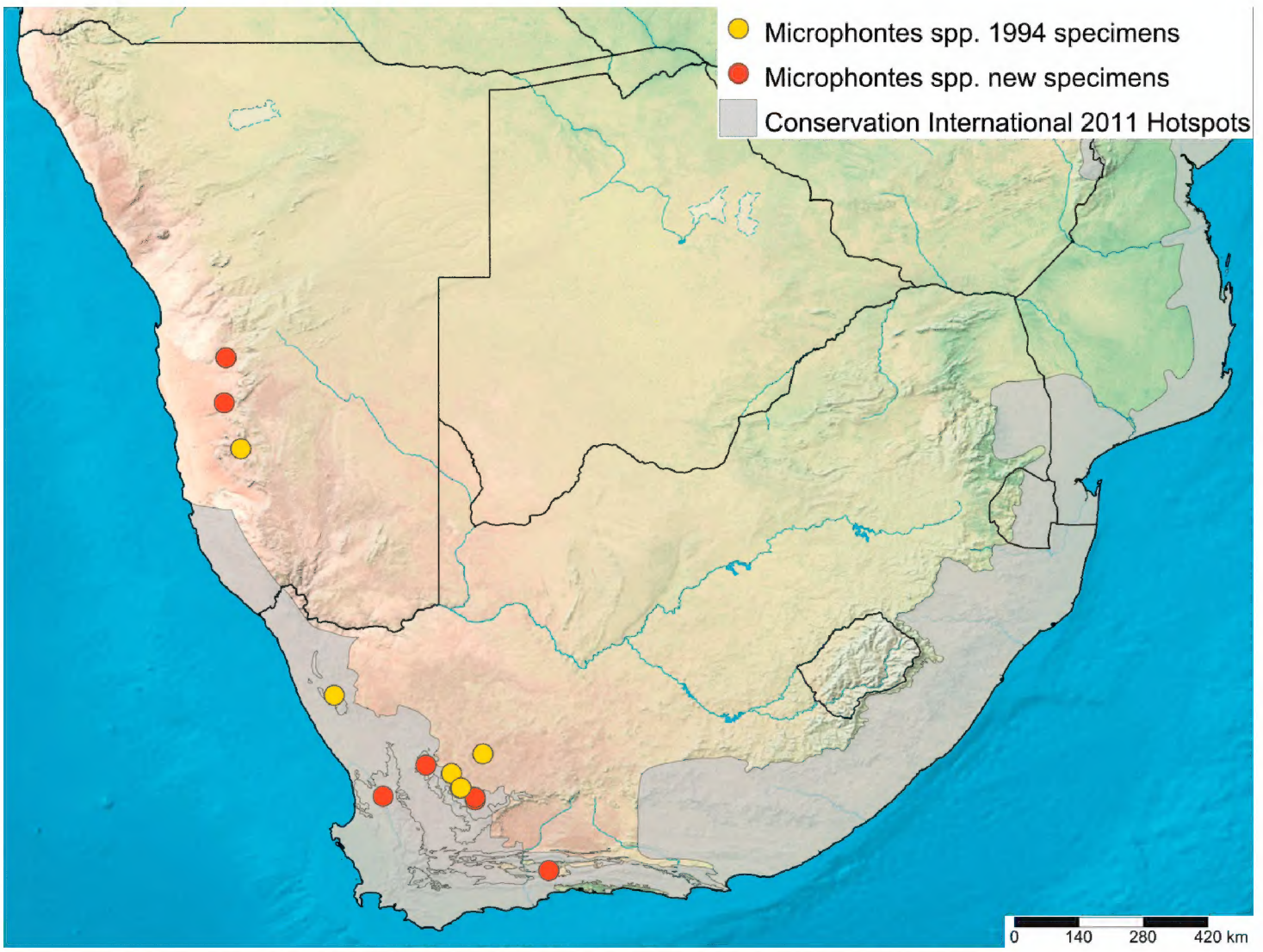


Figure 5. Map of Southern Africa with elevational relief, Biodiversity Hotspots (*sensu* Conservation International) and distribution of *Microphontes* specimens studied in 1994 and now (SimpleMappr 10597). Map data available in Google Earth KML file 10597 and also through GBIF (data-set http://www.gbif.org/dataset/4c13483d-a2ac-4c61-9087-c4e1a3c7b91d, DOI https://doi.org/10.15468/m2vwyh).

Description. *Wing* (Figs 6, 11, 15, 26, 30, 36, 38, 42, 44, 54): 3.0–5.5 mm, hyaline, evenly microtrichose; *C* circumambient (developed around entire wing), anterior wing margin straight; R_{2+3} distally relatively straight, r_1 open; R_4 terminating anterior to wing apex, relatively straight, stump vein (R_3) absent (except in left wing of one specimen); r_4 open, R_4 and R_5 more or less parallel; R_5 terminating posterior to wing apex; r_5 open; M_1 terminating posterior to wing apex; cell *d* closed by base of M_2 and *m-m*, M_2 and *m-m* not aligned, *r-m* situated either in proximal or distal half or in centre; m_3 open; *cua* open; alula reduced in size to small lobe; microtrichia on posterior wing margin arranged in a single plane.

♀ *abdomen and genitalia* (Figs 21–25): T7 and S7 without modifications, ovipositor comprised of 8th and following segments, T6–8 either grey pubescent or T8 entirely or partly apubescent, setation directed anteriorly on T6–7 and dorsally on T8 or entirely dorsally; postero-paramedian T8 pores present, either distinct and opening slightly elevated above tergite surface or indistinct and not elevated; T8 with or without internal apodeme anteriorly, S8 plate-like, hypogynial valves separated (surrounded by membrane); T9 and T10 entirely fused, sclerites not distinguishable, T10 divided into 2 heavily sclerotised acanthophorite plates, with 6–9 acanthophorite spines per plate; cerci simple and flat, long yellowish setose; 3 spermathecae, either all equally large or

median spermatheca larger than lateral ones, reaching anterior end of segment 5, 6, or 7; common spermathecal duct either short and not extending beyond tip of genital fork (S9, furca) or very long, extending well-beyond tip of genital fork, individual spermathecal ducts either short or long; ejection apparatus not observable; spermathecal reservoirs formed by either more or less expanded ducts to sac-shaped reservoirs or spherical reservoirs, heavily sclerotised; genital fork (S9, furca) formed by single sclerite either inverted Y-shaped or inverted V-shaped, median sclerite (at posterior tip) absent, anterior apodeme absent or present, short plate-like apodeme.

♂ *abdomen and terminalia* (Figs 17–20, 56–70): T1-T8 and S1-S8 either entire (without modifications) or T1–T7 and S1–S7 entire and T8 + S8 reduced to ring of sclerites; hypopygium light brown to black, rotated either by 90°or 180°, directed posteriorly; epandrium divided medially into 2 halves, joined proximally; hypandrium well-developed, triangular, posterior margin with either short or long postero-median projection, distinctly separated from epandrium by gonocoxite, but approximating epandrium proximally, not fused to gonocoxite; gonocoxite entirely free from epandrium; gonocoxal apodeme present, short, entirely confined to hypopygium; gonostylus present, positioned proximally on gonocoxite; subepandrial sclerite asetose, ventrally smooth (without protuberances), laterally straight (without protuberances), distal margin simple, straight margin; cerci separate (not fused medially); phallus very short, tip at level of origin of gonostyli, 1 phallic prong, tip pointed, without any protuberance, parameral sheath short (sperm sac entirely free), lateral ejaculatory process present, large triangular sclerite, lateral ejaculatory process and ventral parameral sheath free (not surrounded by ventral parameral sheath), ejaculatory apodeme formed by single vertical plate (2 lateral surfaces).

***Microphontes ericfisheri* sp. n.**
http://zoobank.org/483F65F1-9050-4227-B601-793BEA4A377C
Figs 6–8, 56–57, 71

Etymology. The species is named after Eric M. Fisher who is one of the most knowledgeable Nearctic and Neotropical Asilidae taxonomists, present and past, to recognise his contributions to the study of assassin flies. This species was unveiled at the 9th International Congress of Dipterology (25–30 November 2018) in Windhoek, Namibia during the Asilidae symposium organised to honour a contemporary colleague, Jason Londt and entitled, "Taxonomy and phylogeny of Asilidae – honouring 40 years of Afrotropical research by Jason Londt" on 27 November 2018.

Diagnosis. The species is distinguished from congeners by the distinctly wider than long and transversely rectangular abdominal tergites, the entirely setose postpronotal lobes and dorsal and posterior anepisternum (no macrosetae), the brown-pubescent appearing abdomen (in dorsal view), features of the male terminalia such as the long postero-median projection on the hypandrium and shape of the gonostyli and distribution in the Little Karoo in southern South Africa.

Description. *Head*: wider than high, brown; vertex and compound eyes at same level; facial swelling indistinct, only lower facial margin slightly developed, silver pu-

Figures 6–8. *Microphontes ericfisheri* sp. n. (♂ Holotype, USNMENT01115122): **6** dorsal (Morphbank #861782) **7** lateral (#86178) **8** head anterior (#861787). Scale bar: 5 mm (**6–7**), 1 mm (**8**).

bescent; mystax white macrosetose, restricted to lower facial margin, short, reaching tip of proboscis; ommatidia of same size; postgena posterior margin simple, smooth; frons (at level of antennal insertion) slightly diverging laterally, grey pubescent, light brown setose; ocellar tubercle greyish-brown pubescent, light brown setose; vertex brown pubescent, yellowish to light brown macrosetose; median occipital sclerite (m ocp scl) with several yellowish macrosetose; postocular (pocl) setae slightly angled anteriorly distally, yellowish macrosetae; occiput predominantly grey pubescent, yellowish setose; compound eye posterior margin (in lateral view) straight or slightly curved throughout.

Proboscis and maxillary palpus: proboscis straight, brown; postmentum plate-like, straight, ventral margin entirely smooth, white setose ventrally; prementum circular, with dorso-median flange, asetose; labella reduced, fused to prementum only ventrally, only forming distal tip of proboscis, rounded; maxillary palpus brown, two-segmented, long yellowish setose, cylindrical; stipites fused medially, but with V-shaped indentation, apubescent, long white setose.

Antenna: light brown; scape 1.5× as long as pedicel, short and long yellowish setose and macrosetose ventrally; pedicel short yellowish setose dorsally and long yellowish macrosetose ventrally; postpedicel and stylus broken off.

Thorax: brown, postpronotal lobes and lateral scutum orange to light brown; prosternum white pubescent, separated from proepisternum, square to rectangular in shape (straight dorsally); proepisternum white pubescent, long yellowish macrosetose;

cervical sclerite long yellowish setose; antepronotum white pubescent, short yellowish setose medially, long and weakly yellowish macrosetose laterally; postpronotum white pubescent, long yellowish setose medially and sub-laterally, long and weakly yellowish macrosetose laterally; postpronotal lope long yellowish setose; pleuron white pubescent; proepimeron long yellowish setose anteriorly; anepisternum long yellowish setose dorsally (setae directed dorsally), long yellowish setose postero-medially (setae directed posteriorly), supero-posteriorly long yellowish setose (indistinguishable from other dorsal anepisternal setation); anterior basalare long yellowish setose medially, posterior basalare asetose; anepimeron asetose, katepisternum asetose, katepimeron asetose, katatergite long yellowish macrosetose, meron + metanepisternum asetose, metakatepisternum asetose, metepimeron asetose, anatergite asetose; scutum predominantly light brown pubescent, paramedian stripes and sub-lateral spots (divided by transverse suture) brown pubescent, scutum setation: long yellowish setose, setae with small sockets, 1 npl setae, 1 spa setae, 1 pal setae, 2–3 long yellowish postsutural dc macrosetae, acr setae long yellowish presuturally and postsuturally, median posterior scutum (between dc setae) long yellowish setose, setae directed anteriorly; scutellum grey pubescent, ds sctl setae present, long yellowish setae, ap sctl setae present, 6–8 long yellowish macrosetose; postmetacoxal area entirely membranous.

Leg: light brown to brown, apubescent, all setae circular in cross section; pro coxa brown, grey pubescent, white setose and macrosetose; pro femur brown, short white setose, yellowish macrosetose: 3–4 postero-dorsal distally; pro tibia light brown to brown, short white setose, yellowish macrosetose: 4 in 1 antero-dorsal row, 4 in 1 dorsal row, 6 in 1 posterior row, 5 in 1 postero-ventral row, distal tip with 3–4 long yellowish macrosetae; mes coxa brown, grey pubescent, yellowish macrosetose; mes femur brown, short and long white setose, yellowish macrosetose: 2 anterior proximally, 2–3 posterior distally; mes tibia light brown to brown, short white setose, yellowish macrosetose: 6 in 1 dorsal row, 6 in 1 antero-ventral row, 6 in 1 postero-ventral row, distal tip with 6 long yellowish macrosetae; met coxa brown, grey pubescent, white setose and macrosetose, anteriorly without any protuberance; met trochanter yellowish macrosetose, cylindrical, medially without any protuberance; met femur brown, long white setose, yellowish macrosetose: 5 in 1 anterior row, 1 antero-dorsal sub-distally, 1 dorsal distally; met tibia brown, straight, short white setose, yellowish macrosetose: 3 in 1 anterior row, 5 in 1 antero-ventral row, 4 in 1 dorsal row, distal tip with 7 long yellowish macrosetae; proximal pro and mes tarsomere as long as following 2 tarsomeres combined, proximal met tarsomere longer than 2 following tarsomeres combined, proximal met tarsomere as wide as following tarsomeres; pro tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 short yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; mes tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 short yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; met tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 short yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; pulvilli well-developed (as long as claw); claw abruptly angled distally, pointed; empodium setiform, approximately ½ length of claw.

Wing: 3.6 mm.

Abdomen: shape compressed, T2–3 distinctly transversely rectangular (length to width ratio > 1:3), brown, tergites smooth, setae with small sockets only; T1 yellowish setose, postero-laterally long yellowish macrosetose, grey pubescent, anterior ½, except laterally, membranous, dorsal surface smooth, without protuberances; T2–8 entirely sclerotised, brown, grey pubescent: in dorsal view T2 appearing brown pubescent in posterior ½, T3–7 appearing entirely brown pubescent (except lateral-most margins), in lateral view T2 appearing brown pubescent in posterior ½, T3–4 appearing entirely brown pubescent (area broader distally), T5–7 appearing brown pubescent in posterior ½, short yellowish setose, long yellowish setose antero-laterally on T2, marginal macrosetae absent from T2–8, medial macrosetae absent from T2–8; S1–8 brown, lightly grey pubescent, short yellowish setose.

Female: unknown.

Male (Figs 56–57): T1–T7 and S1–S7 entire, T8 + S8 reduced to ring of sclerites; hypopygium dark brown, rotated by 180°; hypandrium well-developed, triangular, posterior margin with long postero-median projection.

Type locality: SOUTH AFRICA: *Western Cape*: De Zeekoe Guest Farm, Olifantsrivier margin, 33°38'25"S, 022°08'34"E (-33.64028, 22.14278).

Material examined. SOUTH AFRICA: *Western Cape*: 1♂ De Zeekoe Guest Farm, Olifantsrivier margin, 33°38'25"S, 022°08'34"E, 269 m, 2015-12-07 collected a.m. (9:00–noon), sandy riparian vegetation, perching on low vegetation, Dikow, T. (Holotype USNMENT01115122, USNM).

Distribution, biodiversity hotspots, phenology and biology. Known only from the type locality in the Little Karoo of South Africa (Fig. 71). A rarely collected species known only from a single specimen and collecting event in 2015 (Table 1). The species is endemic to the Succulent Karoo biodiversity hotspot. Adult flies are active in mid summer in a winter rainfall region (Table 2). Nothing is known of the biology.

Microphontes gaiophanes sp. n.

http://zoobank.org/6D24A9CA-B94F-4FF5-AC73-1DFCDAD30EF3

Figs 1–2, 9–25, 62–63, 72

Etymology. Greek *gaiophanes* = earth-coloured. Refers to the beautiful earth tone colouration of this species.

Diagnosis. The species is distinguished from congeners by the more or less square abdominal tergites, the short macrosetose dorsal anepisternum, the extensively macrosetose ante- and postpronotum, the overall brown colouration and the grey pubescent female abdominal tergite 8.

Description. *Head*: wider than high, brown; vertex and compound eyes at same level; facial swelling indistinct, only lower facial margin slightly developed, silver pubescent; mystax white macrosetose, restricted to lower facial margin, short, reaching tip of proboscis; ommatidia of same size; postgena posterior margin simple, smooth;

Table 1. Collecting event summary for *Microphontes* species.

Species	# Specimens	# Collecting events	Earliest collection	Most recent collection
M. ericfisheri sp. n.	1	1	2015	2015
M. gaiophanes sp. n.	17	1	2017	2017
M. jasonlondti sp. n.	4	3	1986	1998
M. kryphios sp. n.	4	2	1990	2002
M. megoura	9	1	1936	1936
M. safra	5	3	1974	2012
M. whittingtoni	3	2	1990	2008
Microphontes sp.	1	1	1999	1999
summary	44	14	1936	2017

Table 2. Seasonal incidence of *Microphontes* species through number of specimens collected and unique collecting events in each month (data given as # specimens/# collecting events when more than one specimen has been collected). Months abbreviated starting with July.

Species	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
M. ericfisheri sp. n.	–	–	–	–	–	1	–	–	–	–	–	–
M. gaiophanes sp. n.	–	–	17/1	–	–	–	–	–	–	–	–	–
M. jasonlondti sp. n.	–	–	–	–	4/3	–	–	–	–	–	–	–
M. kryphios sp. n.	–	–	–	–	4/2	–	–	–	–	–	–	–
M. megoura	–	–	–	–	9/1	–	–	–	–	–	–	–
M. safra	–	–	–	–	–	–	–	5/3	–	–	–	–
M. whittingtoni	–	–	–	–	3/2	–	–	–	–	–	–	–
Microphontes sp.	–	–	–	–	1	–	–	–	–	–	–	–
total	–	–	17/1	–	21/9	1	–	5/3	–	–	–	–

frons (at level of antennal insertion) slightly diverging laterally, greyish-brown pubescent, light brown macrosetose; ocellar tubercle brown pubescent, light brown setose; vertex brown pubescent, yellowish to light brown macrosetose; median occipital sclerite (m ocp scl) with several yellowish macrosetose; postocular (pocl) setae slightly angled anteriorly distally, yellowish macrosetae; occiput predominantly grey pubescent, yellowish setose; compound eye posterior margin (in lateral view) straight or slightly curved throughout.

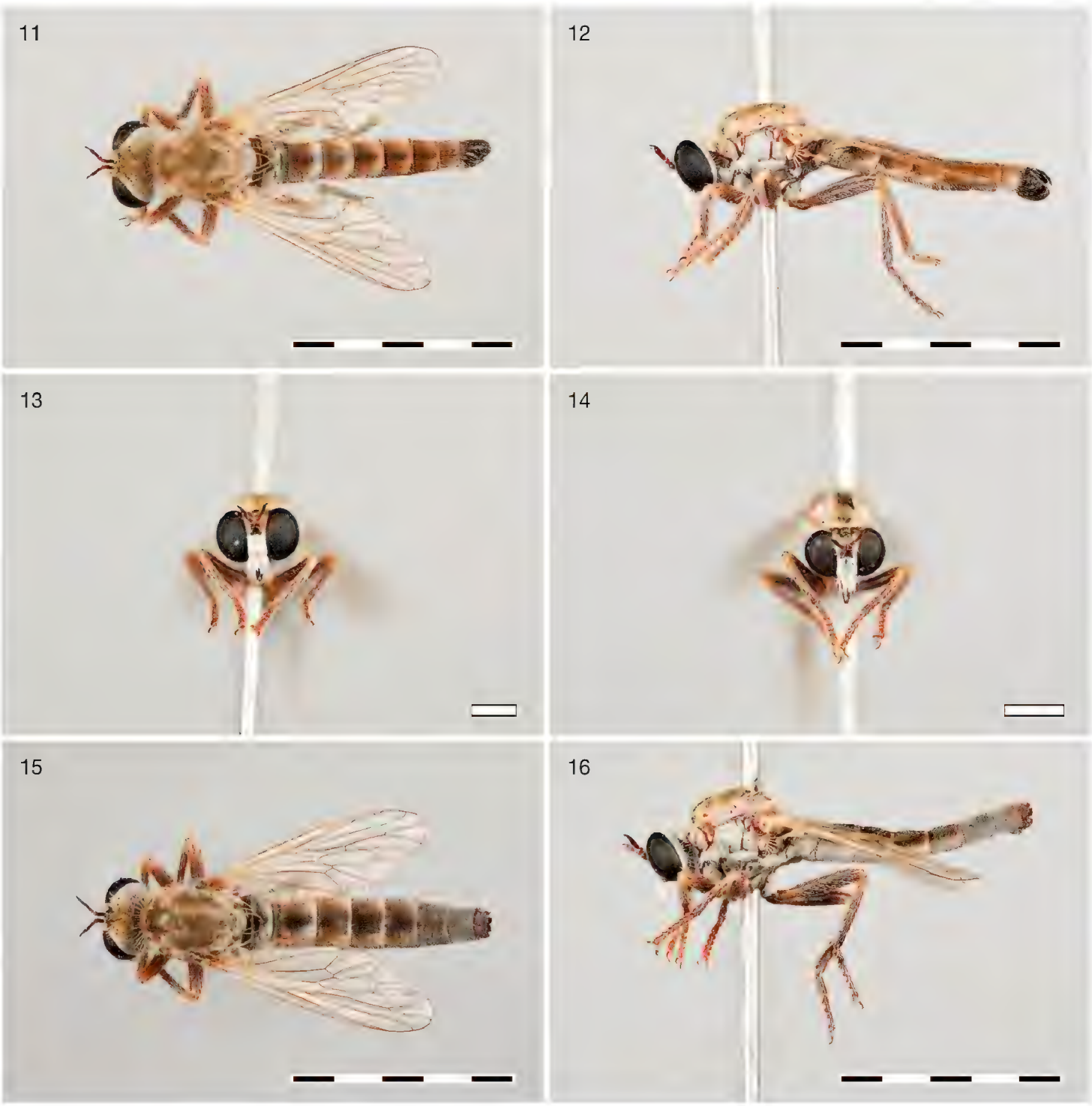
Proboscis and maxillary palpus: proboscis straight, dark brown; postmentum plate-like, straight, ventral margin entirely smooth, white setose ventrally; prementum circular, with dorso-median flange, asetose; labella reduced, fused to prementum only ventrally, only forming distal tip of proboscis, rounded; maxillary palpus brown, two-segmented, long yellowish setose, cylindrical; stipites fused medially, but with V-shaped indentation, apubescent, long white setose.

Antenna: light brown, lightly grey pubescent; scape 1.5× as long as pedicel, short and long yellowish setose and macrosetose ventrally; pedicel short yellowish setose ventrally and dorsally; postpedicel cylindrical (same diameter throughout), 1.5× as long as scape and pedicel combined, asetose; stylus comprised of 1 element, 0.28× as long as postpedicel, asetose; apical seta-like sensory element situated apically on stylus.

Figures 9–10. Photographs of *M. gaiophanes* sp. n. in nature on sand dune as in Figs 1–2: **9** ♂ resting on sand (note that pro-, mes- and metathoracic legs are held sideways and up so that tarsi do not touch sand, Morphbank #861774) **10** ♀ resting on dry vegetation just above ground (#861777). Photographs by T. Dikow.

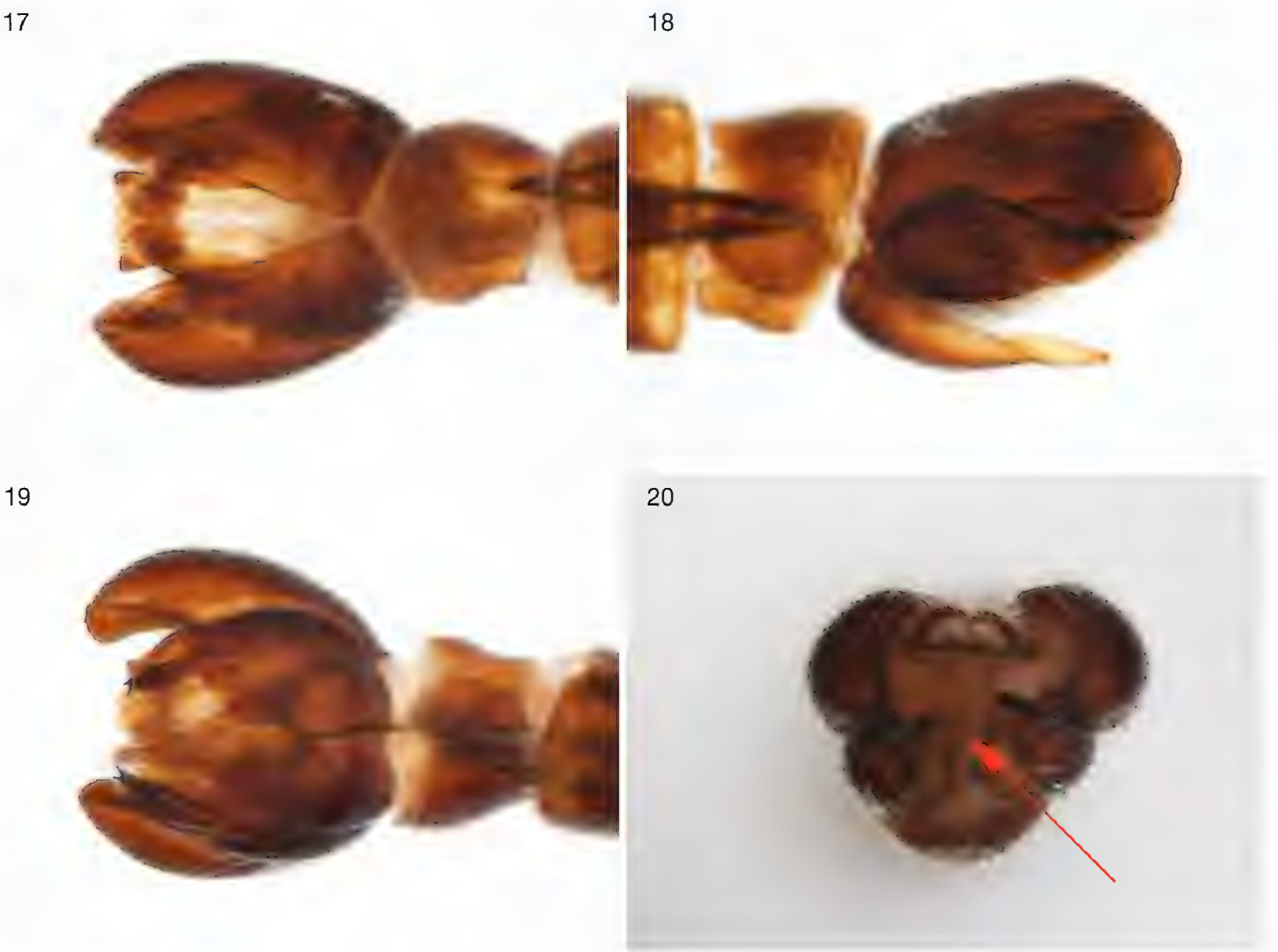
Thorax: brown, postpronotal lobes and lateral scutum orange to light brown; prosternum grey pubescent, separated from proepisternum, square to rectangular in shape (straight dorsally); proepisternum grey pubescent, long yellowish macrosetose; cervical sclerite long yellowish setose; antepronotum grey pubescent, short yellowish setose and long yellowish macrosetose; postpronotum grey pubescent, long yellowish macrosetose medially and laterally, long yellowish setose sub-laterally; postpronotal lope short and long yellowish macrosetose; pleuron grey pubescent; proepimeron short yellowish macrosetose anteriorly; anepisternum short yellowish macrosetose dorsally, superoposteriorly short yellowish macrosetose (indistinguishable from other dorsal anepisternal setation); anterior basalare short yellowish setose dorsally, posterior basalare asetose; anepimeron asetose, katepisternum predominantly asetose, postero-dorsally yellowish setose, katepimeron asetose, katatergite white setose and long yellowish macrosetose, meron + metanepisternum asetose, metakatepisternum asetose, metepimeron asetose, anatergite asetose; scutum predominantly grey pubescent, antero-sublaterally weakly grey pubescent (almost appearing apubescent), median longitudinal stripe and mediolaterally brown pubescent, scutum setation: short light brown setose, setae with small sockets, 2 npl setae, 1–2 spa setae, 2 pal setae, 3–4 long yellowish postsutural dc macrosetae, acr setae short brown presuturally and postsuturally, median posterior scutum (between dc setae) asetose; scutellum grey pubescent, ds sctl setae absent, ap sctl setae present, 6–8 long light brown macrosetae; postmetacoxal area entirely membranous.

Leg: light brown to brown, apubescent, all setae circular in cross section; pro coxa dark brown proximally, light brown distally, grey pubescent, white setose and macrosetose; pro femur brown, short white setose, yellowish macrosetose: 1 anterior proximally, 1 postero-dorsal distally, 1 dorsal distally; pro tibia light brown to brown, short white setose, yellowish macrosetose: 4 in 1 antero-dorsal row, 4 in 1 dorsal row, 2 in 1 posterior row, 3 in 1 postero-ventral row, distal tip with 5–6 long yellowish macrosetae; mes coxa brown, grey pubescent, white setose and yellowish macrosetose; mes femur brown, short white setose, yellowish macrosetose: 1 antero-dorsal proximally,



Figures 11–16. *Microphontes gaiophanes* sp. n.: **11** ♂ Paratype (USNMENT01384092) dorsal (Morphbank #861767) **12** same, lateral (#861769) **13** same, head anterior (#861771) **14** ♀ Paratype (USNMENT01384008) head anterior (#861474) **15** same, dorsal (#861470) **16** same, lateral (#861472). Scale bars: 5 mm (**11–12, 15–16**), 1 mm (**13–14**).

1 antero-dorsal distally, 1–2 dorsal distally; mes tibia light brown to brown, short white setose, yellowish macrosetose: 4 in 2 dorsal rows, 3 in 1 antero-ventral row, 3 in 1 postero-ventral row, distal tip with 5 long yellowish macrosetae; met coxa brown, grey pubescent, white setose and macrosetose, anteriorly without any protuberance; met trochanter yellowish macrosetose, cylindrical, medially without any protuberance; met femur brown, short white setose, yellowish macrosetose: 3–4 in 1 anterior row, 1 proximal ventrally, 2 distal dorsally, 3 apical dorsally; met tibia brown, straight, short white setose, yellowish macrosetose: 4 in 1 anterior row, 3 in 1 antero-ventral row, 4 in 1 dorsal row, distal tip with 6 long yellowish macrosetae; proximal pro, mes and met tarsomeres longer than following 2 tarsomeres combined, proximal met tarsomere

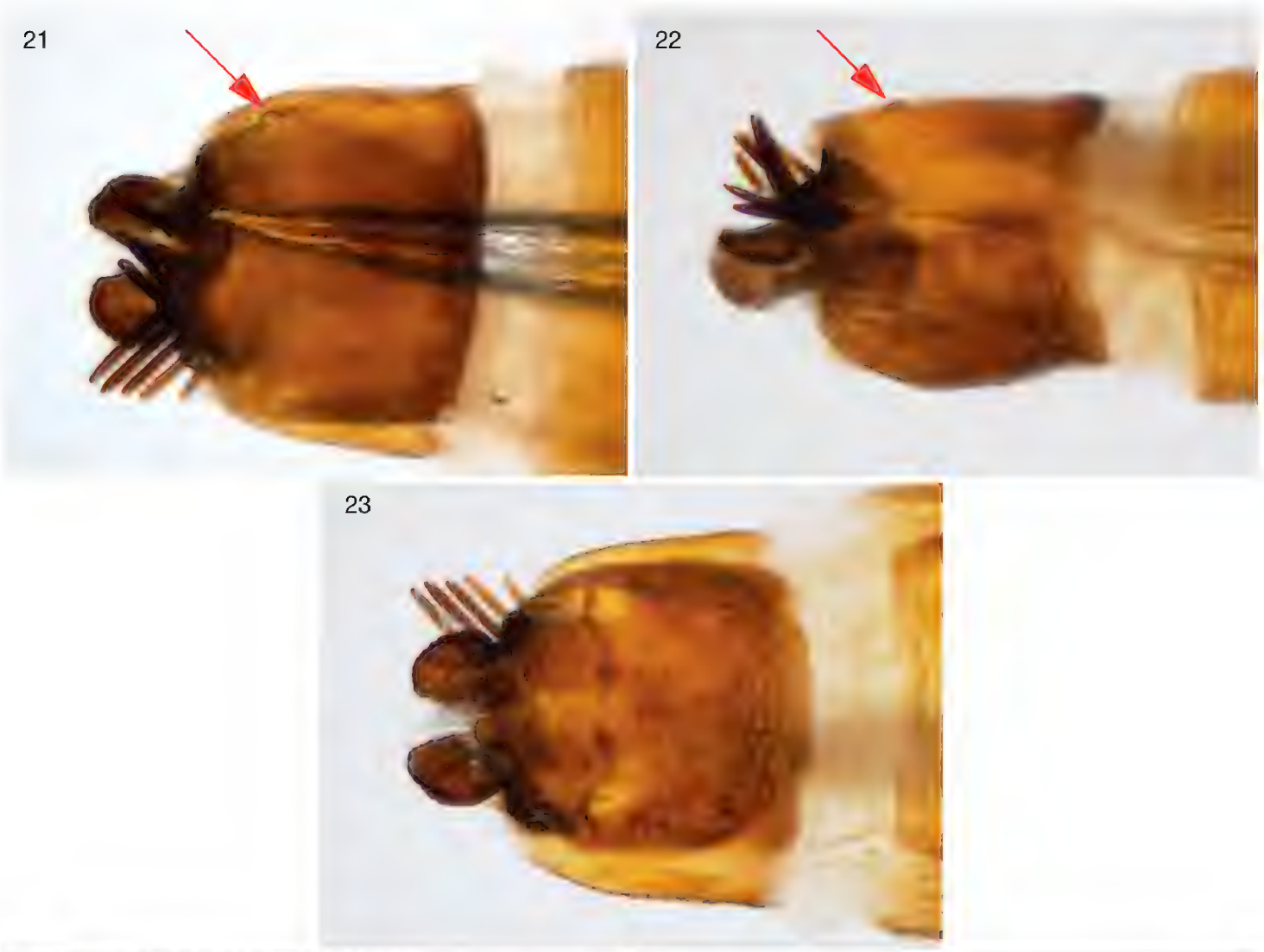


Figures 17–20. *Microphontes gaiophanes* sp. n. ♂ terminalia (cleared, USNMENT01384047): **17** dorsal (Morphbank #861794) **18** same, lateral (#861796) **19** same, ventral (#861798) **20** same, posterior (#861800, arrow highlights tip of phallus). Magnification: 120×.

as wide as following tarsomeres; pro tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 long yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; mes tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 long yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; met tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 long yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; pulvilli well-developed (as long as claw); claw abruptly angled distally, pointed; empodium setiform, approximately ½ length of claw.

Wing: 4.2–5.5 mm.

Abdomen: shape regular, T2–3 somewhat square (length to width ratio = 1:1.2), brown to black, laterally orange to light brown, tergites smooth, setae with small sockets only; T1 yellowish setose, postero-laterally long yellowish macrosetose, grey pubescent, anterior ¼, except laterally, membranous, dorsal surface smooth, without protuberances; T2–8 entirely sclerotised, brown, grey pubescent: in dorsal view appearing brown pubescent medially (area broader anteriorly) except distal margin, in lateral view appearing brown pubescent on dorsal surface, short yellowish setose, long yellowish setose antero-laterally on T2, marginal macrosetae absent from T2–8, medial macrosetae absent from T2–8; S1–8 dark brown, lightly grey pubescent, short yellowish setose.



Figures 21–25. *Microphontes gaiophanes* sp. n. ♀ terminalia: **21** USNMENT01384130 (cleared), dorsal (Morphbank #861803) **22** same, lateral (#861805) **23** same, ventral (#861807) **24** USNMENT01384008, dorsal (Morphbank #861809) **25** same, lateral (#861811). Arrows highlight postero-paramedian T8 pores. Magnification: 120×.

Female (Figs 21–25): T6–8 grey pubescent, setation directed anteriorly on T6–7 and dorsally on T8; postero-paramedian T8 pores present, distinct, opening slightly elevated above tergite surface; T8 without any internal apodeme anteriorly; T10 divided into 2 heavily sclerotised acanthophorite plates, with 8–9, dark brown acanthophorite spines per plate; 3 spermathecae, median spermatheca larger than lateral ones, reaching anterior end of segment 7; common spermathecal duct very long, extending well beyond tip of genital fork (S9, furca), individual spermathecal ducts short; spermathecal reservoirs formed by more or less expanded ducts to sac-shaped reservoir, heavily

sclerotised; genital fork (S9, furca) formed by single, inverted Y-shaped sclerite, median sclerite (at posterior tip) absent, anterior apodeme present, short plate-like apodeme.

Male (Figs 17–20): T1–T8 and S1–S8 entire (without modifications); hypopygium black, rotated by 90°; hypandrium well-developed, triangular, posterior margin with long postero-median projection; gonocoxal apodeme present, short, entirely confined to hypopygium; phallus very short, tip at level of origin of gonostyli, 1 phallic prong, tip pointed, without any protuberance.

Type locality: NAMIBIA: *Erongo*: Namib-Skeleton Coast National Park, off C14, 23°34'22"S, 015°48'37"E (-23.57278, 15.81028).

Material examined. NAMIBIA: *Erongo*: 1♀ 12♂ Namib-Skeleton Coast National Park, off C14, 23°34'22"S, 015°48'37"E, 922 m, 2017-09-26 collected a.m. (9:00–noon), sparsely vegetated sand dune, perching on sand, Dikow, T. (1♂ Holotype USNMENT01384029, NMNW; 1♂ Paratype USNMENT01384061, NMNW; 8♂ Paratypes USNMENT01384037, USNMENT01384047, USNMENT01384049, USNMENT01384080, USNMENT01384082, USNMENT01384092, USNMENT01384118,USNMENT01384134,USNM;1♀nontypeUSNMENT01384499, USNM; 2♂ nontype USNMENT01384419, USNMENT01384459, USNM); 4♀ Namib-Skeleton Coast National Park, off C14, 23°34'22"S, 015°48'37"E, 922 m, 2017-09-26 collected a.m. (9:00–noon), sparsely vegetated sand dune, perching on low, dry vegetation, Dikow, T. (Paratypes USNMENT01384020, NMNW; USNMENT01384008, USNMENT01384018, USNMENT01384130, USNM).

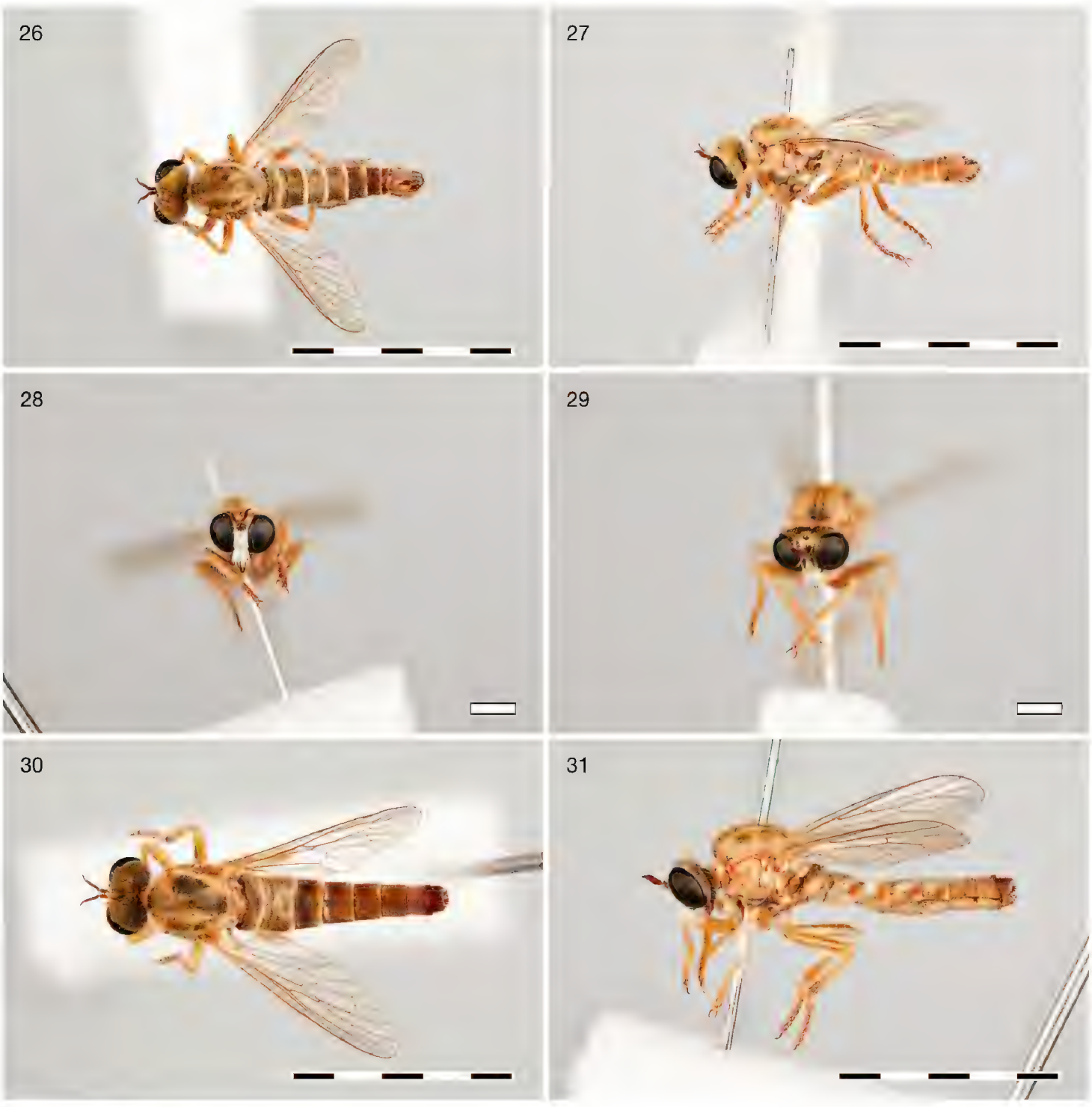
Distribution, biodiversity hotspots, phenology and biology. Known only from the type locality (Fig. 72). A rarely collected species known only from a single collecting event in 2017 (Table 1). Adult flies are active in summer in an arid region on the eastern edge of the Namib Sand Sea (Table 2). Not known to occur in any biodiversity hotspot.

Biological data were gathered during observations in the field at the type locality. Male flies were more active and flew in a very specific pattern of an up-and-down flight, similar to a roller coaster, around the grass boulders or vegetation (see habitat in Figs 1–2). Furthermore, the male flies would land on the sand in open spaces between the grass boulders and perch or rest with their pro-, mes- and metathoracic legs held sideways and up (see Fig. 9). The females appeared less active and were observed to perch or rest on dry, low vegetation close to the grass boulders (Fig. 10, only a single female was collected perching on sand).

***Microphontes jasonlondti* sp. n.**
http://zoobank.org/9CFF13BC-0398-40A7-AE83-AC0035309201
Figs 26–31, 58–59, 71

Microphontes whittingtoni Londt, 1994 (in part)

Etymology. The species is named after Jason G.H. Londt who is without doubt the most knowledgeable Afrotropical Asilidae taxonomist, present and past, to recognise



Figures 26–31. *Microphontes jasonlondti* sp. n.: **26** ♂ Holotype (NMSA-DIP-4768), dorsal (Morphbank #861816) **27** same, lateral (#861818) **28** same, head anterior (#861820) **29** ♀ Paratype (NMSA-DIP-74485), head anterior (#861832) **30** same, dorsal (#861828) **31** same, lateral (#861830). Scale bars: 5 mm (**26–27, 30–31**), 1 mm (**28–29**).

his contributions to the study of assassin flies and who also collected the type series. This species was unveiled at the 9th International Congress of Dipterology (25–30 November 2018) in Windhoek, Namibia during the Asilidae symposium organised in his honour entitled, "Taxonomy and phylogeny of Asilidae – honouring 40 years of Afrotropical research by Jason Londt" on 27 November 2018.

Diagnosis. The species is distinguished from congeners by the only slightly transversely rectangular abdominal tergites, the general brown colouration and a long gonocoxite extending beyond midpoint of the epandrium (in lateral view) in the male terminalia.

Description. Head: wider than high, brown; vertex and compound eyes at same level; facial swelling indistinct, only lower facial margin slightly developed, silver pubescent; mystax white macrosetose, restricted to lower facial margin, short, reaching

tip of proboscis; ommatidia of same size; postgena posterior margin simple, smooth; frons (at level of antennal insertion) slightly diverging laterally, grey pubescent, light brown setose; ocellar tubercle greyish-brown pubescent, light brown setose; vertex brown pubescent, yellowish to light brown macrosetose; median occipital sclerite (m ocp scl) with several yellowish macrosetose; postocular (pocl) setae slightly angled anteriorly distally, yellowish macrosetae; occiput predominantly light brown pubescent, yellowish setose; compound eye posterior margin (in lateral view) straight or slightly curved throughout.

Proboscis and maxillary palpus: proboscis straight, brown; postmentum plate-like, straight, ventral margin entirely smooth, white setose ventrally; prementum circular, with dorso-median flange, asetose; labella reduced, fused to prementum only ventrally, only forming distal tip of proboscis, rounded; maxillary palpus brown, two-segmented, long yellowish setose, cylindrical; stipites fused medially, but with V-shaped indentation, apubescent, long white setose.

Antenna: light brown, lightly grey pubescent; scape 1.5× as long as pedicel, short and long yellowish setose and macrosetose ventrally; pedicel short yellowish setose dorsally and long yellowish macrosetose ventrally; postpedicel cylindrical (same diameter throughout), approximately 2× as long as scape and pedicel combined, asetose; stylus comprised of 1 element, 0.26× as long as postpedicel, asetose; apical seta-like sensory element situated apically on stylus.

Thorax: brown, postpronotal lobes and lateral scutum orange to light brown; prosternum white pubescent, separated from proepisternum, square to rectangular in shape (straight dorsally); proepisternum white pubescent, long yellowish macrosetose; cervical sclerite long yellowish setose; antepronotum white pubescent, short yellowish setose medially, long and weakly yellowish macrosetose laterally; postpronotum white pubescent, long yellowish setose medially and sub-laterally, long and weakly yellowish macrosetose laterally; postpronotal lope long yellowish setose and longer yellowish macrosetose anteriorly; pleuron white pubescent; proepimeron long white setose anteriorly; anepisternum long yellowish setose dorsally (setae directed dorsally), long yellowish setose postero-medially (setae directed posteriorly), supero-posteriorly long yellowish setose (indistinguishable from other dorsal anepisternal setation); anterior basalare long yellowish setose medially, posterior basalare asetose; anepimeron asetose, katepisternum asetose, katepimeron asetose, katatergite long yellowish macrosetose, meron + metanepisternum asetose, metakatepisternum asetose, metepimeron asetose, anatergite asetose; scutum predominantly light brown pubescent, paramedian stripes and sub-lateral spots (divided by transverse suture) brown pubescent, scutum setation: long yellowish setose, setae with small sockets, 1–2 npl setae, 1 spa setae, 2 pal setae, 2–3 long yellowish postsutural dc macrosetae, acr setae long yellowish presuturally and postsuturally, median posterior scutum (between dc setae) long yellowish setose, setae directed anteriorly; scutellum grey pubescent, ds sctl setae present, long yellowish setae, ap sctl setae present, 12–16 long yellowish macrosetose; postmetacoxal area entirely membranous.

Leg: light brown to brown, apubescent, all setae circular in cross section; pro coxa brown, grey pubescent, white setose and macrosetose; pro femur orange to light brown, short white setose, white macrosetose: 2–3 postero-dorsal distally; pro tibia light brown to brown, short white setose, yellowish macrosetose: 4 in 1 antero-dorsal row, 4 in 1 dorsal row, 5 in 1 posterior row, 6 in 1 postero-ventral row, distal tip with 5–6 long yellowish macrosetae; mes coxa brown, grey pubescent, yellowish macrosetose; mes femur brown, short white setose, yellowish macrosetose: 2 anterior proximally and medially, 1 antero-dorsal distally, 2–3 posterior distally; mes tibia light brown to brown, short white setose, yellowish macrosetose: 4 in 1 anterior row, 5 in 1 dorsal row, 5 in 1 antero-ventral row, 4 in 1 posterior row, 4 in 1 postero-ventral row, distal tip with 6 long yellowish macrosetae; met coxa brown, grey pubescent, white setose and macrosetose, anteriorly without any protuberance; met trochanter yellowish macrosetose, cylindrical, medially without any protuberance; met femur brown, long white setose, yellowish macrosetose: 5 in 1 anterior row, 1 antero-dorsal sub-distally, 1 dorsal distally; met tibia brown, straight, short white setose, yellowish macrosetose: 4 in 1 anterior row, 4 in 1 antero-ventral row, 3 in 1 dorsal row, distal tip with 5 short yellowish macrosetae; proximal pro and mes tarsomere as long as following 2 tarsomeres combined, proximal met tarsomere longer than 2 following tarsomeres combined, proximal met tarsomere as wide as following tarsomeres; pro tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 short yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; mes tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 short yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; met tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 short yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; pulvilli well-developed (as long as claw); claw abruptly angled distally, pointed; empodium setiform, approximately ½ length of claw.

Wing: 3.5–4.5 mm, stump vein (R_3) absent, rarely present, short stump vein (R_3) not reaching R_{2+3}.

Abdomen: shape somewhat compressed, T2–3 transversely rectangular (length to width ratio = 1:1.5–1:2), brown, tergites smooth, setae with small sockets only; T1 yellowish setose, postero-laterally long yellowish macrosetose, grey pubescent, anterior ¼, except laterally, membranous, dorsal surface smooth, without protuberances; T2–8 entirely sclerotised, brown, grey pubescent: in dorsal view T2–3 appearing partly brown pubescent, T4–7 appearing entirely brown pubescent, in lateral view T2 appearing brown pubescent only on posterior 1/5, T3–7 appearing brown pubescent in sublateral triangular pattern, short yellowish setose, long yellowish setose antero-laterally on T2, marginal macrosetae absent from T2–8, medial macrosetae absent from T2–8; S1–8 brown, lightly grey pubescent, short yellowish setose.

Female: T6–7 grey pubescent, T8 apubescent, setation directed anteriorly on T6–7 and dorsally on T8; postero-paramedian T8 pores present, indistinct, opening not elevated above tergite surface; S8 plate-like, hypogynial valves separated (surrounded by membrane); T9 and T10 entirely fused, sclerites not distinguishable, T10 divided into

2 heavily sclerotized acanthophorite plates, with 6, dark brown acanthophorite spines per plate; cerci simple and flat, long yellowish setose.

Male (Figs 58–59): T1–T7 and S1–S7 entire, T8 + S8 reduced to ring of sclerites; hypopygium dark brown, rotated by 180°; hypandrium well-developed, triangular, posterior margin with long postero-median projection.

Type locality: SOUTH AFRICA: *Northern Cape*: Renoster River (18 km N Sutherland), 32°15'10"S, 020°41'39"E (-32.2527803, 20.69417).

Material examined. SOUTH AFRICA: *Northern Cape*: 1♀ Renoster River, 24 km N Sutherland, 32°12'18"S, 020°41'41"E, 1290 m, 1998-11-11, hard earth near stream, Londt, J. (Paratype, NMSA-DIP-74485, NMSA); 2♂ Renoster River, 18 km N Sutherland, 32°15'10"S, 020°41'39"E, 1290 m, 1998-11-07, Karoo macchia, Londt, J., Londt, B. (Holotype NMSA-DIP-4768, Paratype NMSA-DIP-27120, NMSA); 1♂ Williston, 10 km W, 31°21'01"S, 020°50'59"E, 1060 m, 1986-11-15, sand Acacias, Londt, J., Quickelberge, C. (NMSA-DIP-4764, NMSA).

Distribution, biodiversity hotspots, phenology and biology. Known only from three localities in the Northern Cape of South Africa (Fig. 71). A rarely collected species known only from three collecting events in 1986 and 1998 (Table 1). The species is primarily distributed in the Succulent Karoo biodiversity hotspot, but also occurs in the Nama Karoo outside of any hotspot (Fig. 71). Adult flies are active in early summer in a winter rainfall region (Table 2). Biological data available pertain to the habitat preferences. Specimen occurrence data indicate that the species occurs in habitats near rivers.

Remarks. The male specimen from near Williston (NMSA-DIP-4764) was studied by Londt (1994) and assigned paratype status of the then newly described species *M. whittingtoni*. The male terminalia were dissected, but not illustrated by Jason Londt and, when we studied the specimen and terminalia attached in a micro-vial, it became clear that the male terminalia of the holotype of *M. whittingtoni* (NMSA-DIP-4777) do not correspond to the terminalia of this specimen. In particular, the holotype of *M. whittingtoni* has a short postero-median projection on the hypandrium (Fig. 66) whereas this specimen has a very long hypandrial projection (Fig. 58, see also Remarks under *M. kryphios* sp. n.).

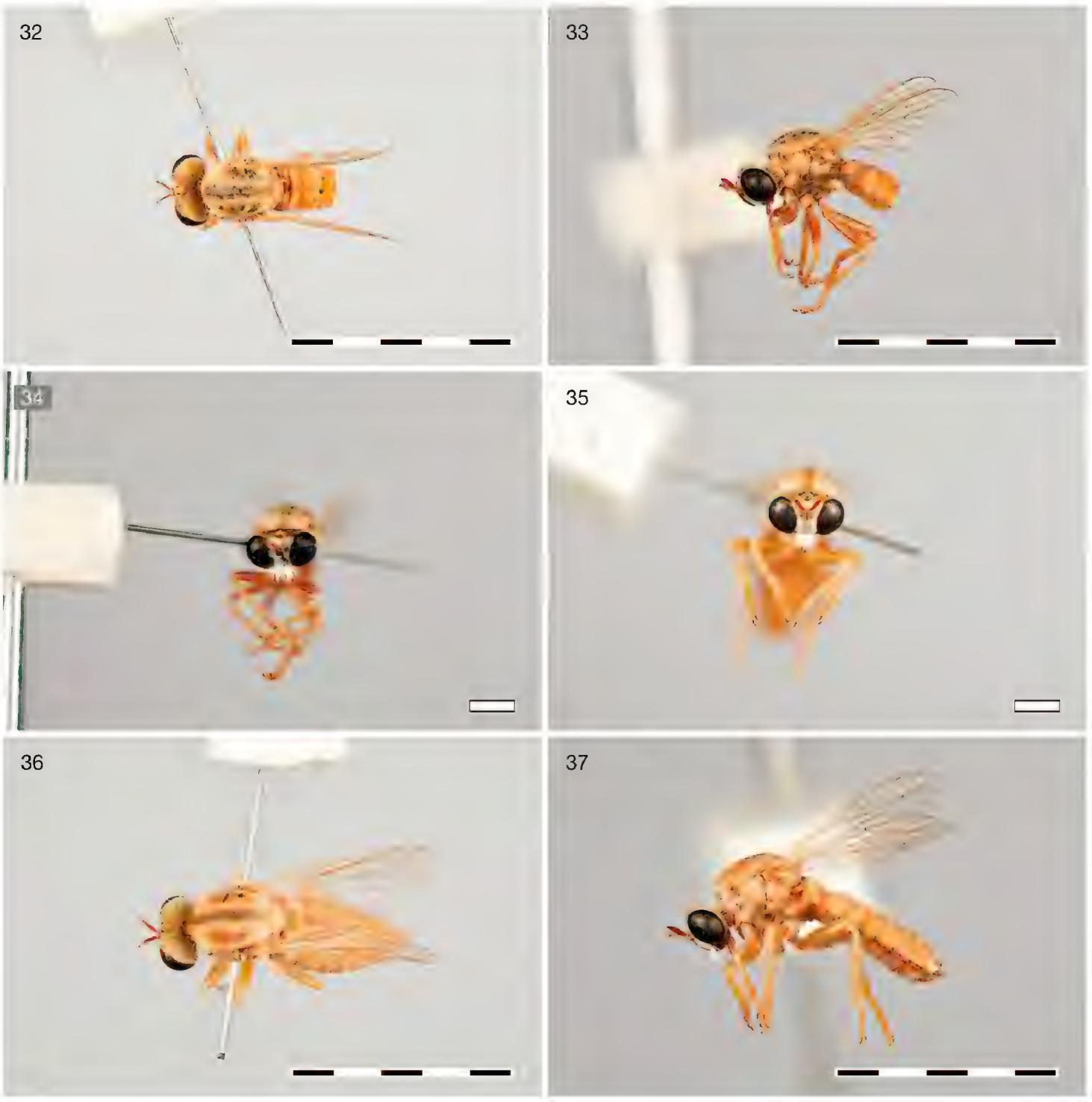
Microphontes kryphios sp. n.

http://zoobank.org/29EA43A6-35D6-4C93-AC89-8A1A9FBA23D4
Figs 32–37, 68–71

Microphontes whittingtoni Londt, 1994 (in part)

Etymology. Greek *kryphios* = hidden, secret. Refers to the fact that this species was hidden amongst the type series of *M. whittingtoni*.

Diagnosis. The species is distinguished from congeners by the small size with a wing length of 3–4 mm, distinctly wider than long and transversely rectangular abdominal tergites, partly macrosetose postpronotal lobes, setose dorsal and posterior



Figures 32–37. *Microphontes kryphios* sp. n.: **32** ♂ Holotype (NMSA-DIP-74620), dorsal (Morphbank #861837) **33** same, lateral (#861839) **34** same, head anterior (#861841) **35** ♀ Paratype (NMSA-DIP-4775), head anterior (#861844) **36** same, dorsal (#861846) **37** same, lateral (#861848). Scale bars: 5 mm (**32–33, 36–37**), 1 mm (**34–35**).

anepisternum and features of the male terminalia such as the long postero-median projection on the hypandrium and shape of the gonostyli.

Description. *Head*: wider than high, brown; vertex and compound eyes at same level; facial swelling indistinct, only lower facial margin slightly developed, silver pubescent; mystax white macrosetose, restricted to lower facial margin, short, reaching tip of proboscis; ommatidia of same size; postgena posterior margin simple, smooth; frons (at level of antennal insertion) slightly diverging laterally, grey pubescent, yellowish setose; ocellar tubercle greyish-brown pubescent, light brown setose; vertex greyish-light brown pubescent, yellowish to light brown macrosetose; median occipital sclerite (m ocp scl) with several yellowish macrosetose; postocular (pocl) setae slightly angled anteriorly

distally, yellowish macrosetae; occiput predominantly grey pubescent, yellowish setose; compound eye posterior margin (in lateral view) straight or slightly curved throughout.

Proboscis and maxillary palpus: proboscis straight, brown; postmentum plate-like, straight, ventral margin entirely smooth, white setose ventrally; prementum circular, with dorso-median flange, asetose; labella reduced, fused to prementum only ventrally, only forming distal tip of proboscis, rounded; maxillary palpus brown, two-segmented, long yellowish setose, cylindrical; stipites fused medially, but with V-shaped indentation, apubescent, long white setose.

Antenna: orange, lightly grey pubescent; scape approximately as long as pedicel, short and long yellowish setose and macrosetose ventrally; pedicel short yellowish setose ventrally and dorsally; postpedicel cylindrical (same diameter throughout), approximately 2× as long as scape and pedicel combined, asetose; stylus comprised of 1 element, 0.15× as long as postpedicel, asetose; apical seta-like sensory element situated apically in cavity on stylus.

Thorax: light brown, scutum with median longitudinal stripe and shorter sublateral longitudinal stripes brown; prosternum white pubescent, separated from proepisternum, square to rectangular in shape (straight dorsally); proepisternum white pubescent, long yellowish macrosetose; cervical sclerite long yellowish setose; antepronotum white pubescent, short yellowish setose medially, long and weakly yellowish macrosetose laterally; postpronotum white pubescent, long yellowish setose medially and sub-laterally, long and weakly yellowish macrosetose laterally; postpronotal lope long yellowish setose and longer yellowish macrosetose anteriorly; pleuron white pubescent; proepimeron long white setose anteriorly; anepisternum long yellowish setose dorsally (setae directed dorsally), long yellowish setose postero-medially (setae directed posteriorly), supero-posteriorly long yellowish setose (indistinguishable from other dorsal anepisternal setation); anterior basalare long yellowish setose medially, posterior basalare asetose; anepimeron asetose, katepisternum asetose, katepimeron asetose, katatergite long yellowish macrosetose, meron + metanepisternum asetose, metakatepisternum asetose, metepimeron asetose, anatergite asetose; scutum white to greyish pubescent, scutum setation: long yellowish setose, setae with small sockets, 1 npl setae, 1 spa setae, 1–2 pal setae, 2–3 long yellowish postsutural dc macrosetae, rarely 3–4 long yellowish postsutural dc macrosetae, acr setae long yellowish presuturally and postsuturally, median posterior scutum (between dc setae) long yellowish setose, setae directed anteriorly; scutellum white pubescent, ds sctl setae present, long yellowish setae, ap sctl setae present, 6–10 long yellowish macrosetose; postmetacoxal area entirely membranous.

Leg: orange to light brown, apubescent, all setae circular in cross section; pro coxa orange to light brown, white pubescent, white setose and macrosetose; pro femur orange to light brown, short white setose, white macrosetose: 2–3 postero-dorsal distally; pro tibia orange to light brown, short white setose, yellowish macrosetose: 5 in 1 antero-dorsal row, 4 in 1 dorsal row, 5 in 1 postero-ventral row, distal tip with 1–2 long yellowish macrosetae; mes coxa orange to light brown, white pubescent, white macrosetose; mes femur orange to light brown, short white setose, yellowish macrosetose: 2

anterior proximally and medially, 2–3 anterior distally, 4 posterior distally; mes tibia orange to light brown, short white setose, yellowish macrosetose: 4 in 1 dorsal row, 5 in 1 antero-dorsal row, 4 in 1 antero-ventral row, 5 in 1 postero-ventral row, distal tip with 5 long yellowish macrosetae; met coxa orange to light brown, white pubescent, white setose and macrosetose, anteriorly without any protuberance; met trochanter yellowish macrosetose, cylindrical, medially without any protuberance; met femur orange to light brown, short white setose, yellowish macrosetose: 6 in 1 anterior row, 6 in 1 antero-ventral row, 3–4 long in 1 postero-ventral row, 1 distal dorsally; met tibia orange to light brown, straight, short white setose, yellowish macrosetose: 4 in 1 anterior row, 4 in 1 antero-ventral row, 5 in 1 dorsal row, distal tip with 5 short yellowish macrosetae; proximal pro and mes tarsomere as long as following 2 tarsomeres combined, proximal met tarsomere longer than 2 following tarsomeres combined, proximal met tarsomere as wide as following tarsomeres; pro tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 short yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; mes tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 short yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; met tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 short yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; pulvilli well-developed (as long as claw); claw abruptly angled distally, pointed; empodium setiform, approximately ½ length of claw.

Wing: 3.0–4.0 mm.

Abdomen: shape compressed, T2–3 distinctly transversely rectangular (length to width ratio > 1:3), orange to light brown, tergites smooth, setae with small sockets only; T1 white setose, postero-laterally long white macrosetose, white pubescent, anterior ½, except laterally, membranous, dorsal surface smooth, without protuberances; T2–8 entirely sclerotised, orange to light brown, white pubescent: in dorsal view T2–5 appearing predominantly apubescent except laterally, T6 appearing apubescent only medially, T7 white pubescent, in lateral view T2–7 appearing apubescent in posterior ¼ except lateral margin, short white setose, long white setose antero-laterally on T2, marginal macrosetae absent from T2–8, medial macrosetae absent from T2–8; S1–8 orange to light brown, lightly grey pubescent, short white setose.

Female: T6–7 predominantly grey pubescent, T8 apubescent medially and posteriorly, setation directed anteriorly on T6–7 and dorsally on T8; postero-paramedian T8 pores present, indistinct, opening not elevated above tergite surface; T10 divided into 2 heavily sclerotised acanthophorite plates, with 7–8, light brown acanthophorite spines per plate.

Male (Figs 68–70): T1–T7 and S1–S7 entire, T8 + S8 reduced to ring of sclerites; hypopygium orange to light brown, rotated by 180°; hypandrium well-developed, triangular, posterior margin with long postero-median projection.

Type locality: SOUTH AFRICA: *Northern Cape*: Kookfontein river (23 km N Middelpos), 31°44'00"S, 020°14'00"E (-31.73333, 20.23333).

Material examined. SOUTH AFRICA: *Northern Cape*: 1♀ 1♂ Kookfontein river, 23 km N Middelpos, 31°44'00"S, 020°14'00"E, 1170 m, 1990-11-29, Whitting-

ton, A., Londt, J. (♂ Holotype NMSA-DIP-74620, ♀ Paratype NMSA-DIP-4775, NMSA); 1♀ 1♂ Calvinia, 12 km S, 31°34'10"S, 019°43'56"E, 1080 m, 2002-09-07, sandy roadside, Londt, J. (pinned in copula NMSA-DIP-4766, NMSA).

Distribution, biodiversity hotspots, phenology and biology. Known from three nearby localities in the Northern Cape of South Africa (Fig. 71). A rarely collected species known only from three collecting events (Table 1). Adult flies are active in early summer in a winter rainfall region (Table 2). The species occurs within the Succulent Karoo biodiversity hotspot, but also outside of it in the Nama Karoo biome. Biological data available pertain to the mating position and habitat preferences. A pair has been collected *in copula* (NMSA-DIP-4766) and remarkably the flies remained in the copulation position after capture in a tail-to-tail position. Specimen occurrence data indicate that the species prefers sandy habitats along rivers.

Remarks. The holotype and paratype of *M. kryphios* sp. n. were studied by Londt (1994) and assigned paratype status of the then newly described species *M. whittingtoni*. The male holotype of *M. kryphios* sp. n. was dissected and the male terminalia illustrated by Jason Londt (see Figs 68–70) to represent *M. whittingtoni*. When we studied the specimen and terminalia attached in a micro-vial, it became clear that the male terminalia of the holotype of *M. whittingtoni* (NMSA-DIP-4777) do not correspond to the illustrations published in figures 51–53 by Londt (1994), which were based on the 23 km N Middelpos specimen that we assign to be the holotype of *M. kryphios* sp. n. In particular, the holotype of *M. whittingtoni* has a short postero-medi-an projection on the hypandrium (Fig. 66) whereas the holotype of our new species *M. kryphios* sp. n. has a very long hypandrial projection (Fig. 68, see also Remarks under *M. jasonlondti* sp. n.).

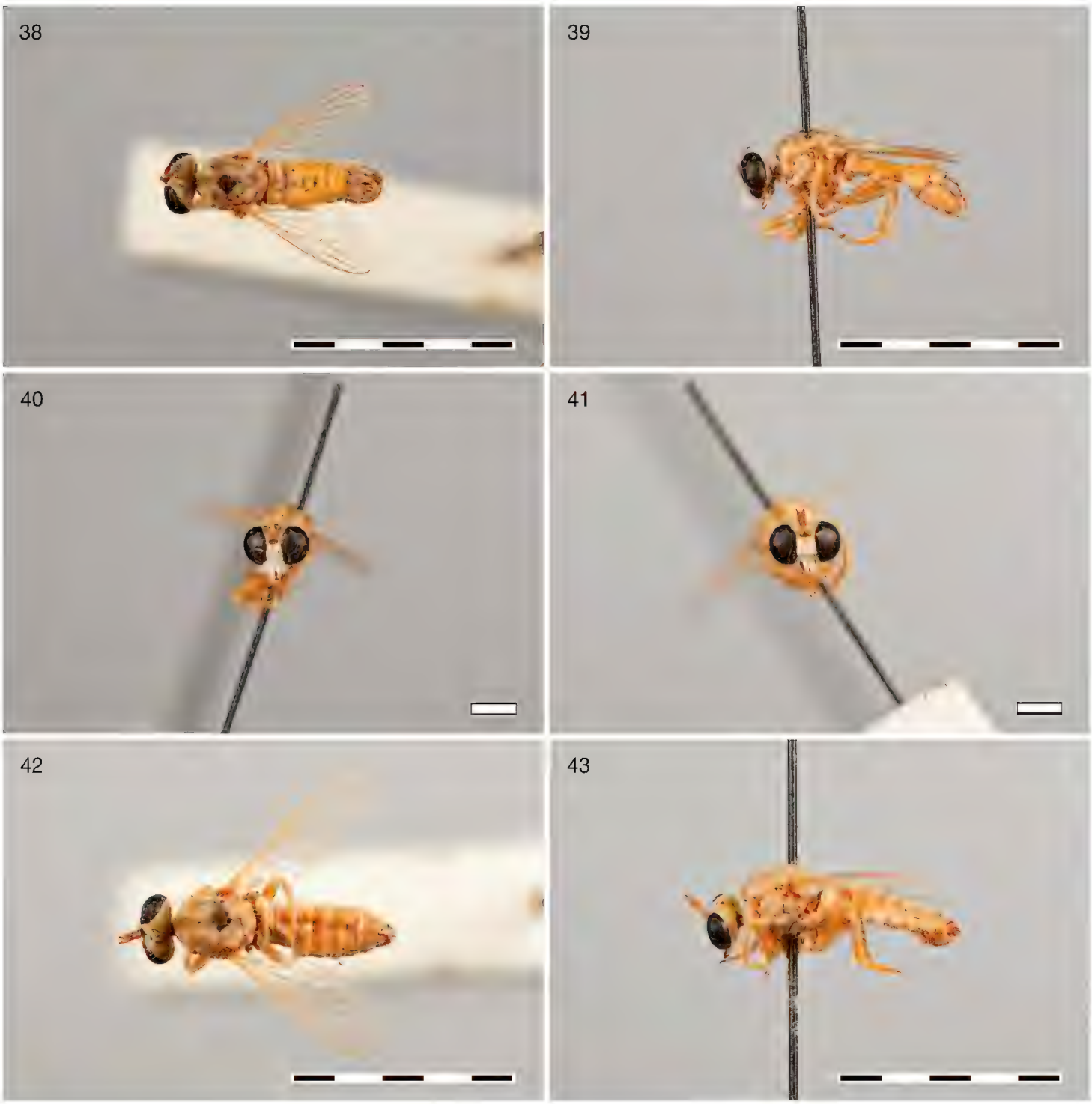
Microphontes megoura Londt, 1994

http://zoobank.org/5CEE3768-26EB-4BCA-8629-E26423B0F7D9
Figs 38–43, 60–61, 71

Microphontes megoura Londt, 1994: 87.

Diagnosis. The species is distinguished from congeners by the small size with a wing length of 3.2–4.1 mm, distinctly wider than long and transversely rectangular abdominal tergites, partly macrosetose postpronotal lobes, macrosetose posterior anepisternum and distribution in Namaqualand in western-most South Africa.

Redescription. *Head*: wider than high, brown; vertex and compound eyes at same level; facial swelling indistinct, only lower facial margin slightly developed, greyish-silver pubescent; mystax white macrosetose, restricted to lower facial margin, short, reaching tip of proboscis; ommatidia of same size; postgena posterior margin simple, smooth; frons (at level of antennal insertion) slightly diverging laterally, grey pubescent, yellowish setose; ocellar tubercle light brown pubescent, light brown setose; vertex greyish-light brown pubescent, yellowish to light brown macrosetose; median



Figures 38–43. *Microphontes megoura*: **38** ♂ Holotype (SAM-DIP-A015480), dorsal (Morphbank #861855) **39** same, lateral (#861857) **40** same, head anterior (#861859) **41** ♀ Paratype (SAM-DIP-A015487), head anterior (#861862) **42** same, dorsal (#861864) **43** same, lateral (#861866). Scale bars: 5 mm (**38–39, 42–43**), 1 mm (**40–41**).

occipital sclerite (m ocp scl) with several yellowish setae, rarely with several yellowish macrosetose; postocular (pocl) setae slightly angled anteriorly distally, yellowish macrosetae; occiput predominantly grey pubescent, yellowish setose; compound eye posterior margin (in lateral view) straight or slightly curved throughout.

Proboscis and maxillary palpus: proboscis straight, brown; postmentum plate-like, straight, ventral margin entirely smooth, white setose ventrally; prementum circular, with dorso-median flange, asetose; labella reduced, fused to prementum only ventrally, only forming distal tip of proboscis, rounded; maxillary palpus light brown, two-segmented, long yellowish setose, cylindrical; stipites fused medially, but with V-shaped indentation, apubescent, long white setose.

Antenna: orange, lightly grey pubescent; scape approximately as long as pedicel, short and long yellowish setose and macrosetose ventrally; pedicel short yellowish setose dorsally and long yellowish macrosetose ventrally; postpedicel cylindrical (same diameter throughout), approximately 2× as long as scape and pedicel combined, asetose; stylus comprised of 1 element, 0.15× as long as postpedicel, asetose; apical seta-like sensory element situated apically in cavity on stylus.

Thorax: orange to light brown, scutum with median longitudinal stripe and shorter sublateral longitudinal stripes brown; prosternum white pubescent, separated from proepisternum, square to rectangular in shape (straight dorsally); proepisternum white pubescent, long yellowish macrosetose; cervical sclerite long yellowish setose; antepronotum white pubescent, short yellowish setose medially, long and weakly yellowish macrosetose laterally; postpronotum white pubescent, long yellowish setose medially and sub-laterally, long and weakly yellowish macrosetose laterally; postpronotal lope long yellowish setose and longer yellowish macrosetose anteriorly; pleuron white pubescent; proepimeron long white setose anteriorly; anepisternum long yellowish setose dorsally (setae directed dorsally), long yellowish macrosetose postero-medially (macrosetae directed posteriorly), supero-posteriorly long yellowish setose (indistinguishable from other dorsal anepisternal setation); anterior basalare long yellowish setose medially, posterior basalare asetose; anepimeron asetose, katepisternum asetose, katepimeron asetose, katatergite long yellowish macrosetose, meron + metanepisternum asetose, metakatepisternum asetose, metepimeron asetose, anatergite asetose; scutum white to greyish pubescent, scutum setation: long yellowish setose, setae with small sockets, 1 npl setae, 1 spa setae, 1–2 pal setae, 2–3 long yellowish postsutural dc macrosetae, acr setae long yellowish presuturally and postsuturally, median posterior scutum (between dc setae) long yellowish setose, setae directed anteriorly; scutellum grey pubescent, ds sctl setae present, long yellowish setae, ap sctl setae present, 6–8 long yellowish macrosetose; postmetacoxal area entirely membranous.

Leg: orange to light brown, apubescent, all setae circular in cross section; pro coxa orange to light brown, white pubescent, white setose and macrosetose; pro femur orange to light brown, short white setose, 5–6 long white setae in antero-ventral and postero-ventral rows, yellowish macrosetose: 3–4 posterior to dorso-posterior distally; pro tibia orange to light brown, short white setose, yellowish macrosetose: 4 in 1 antero-dorsal row, 5–6 in 1 postero-ventral row, distal tip with 3–4 long yellowish macrosetae; mes coxa orange to light brown, white pubescent, yellowish macrosetose; mes femur orange to light brown, short white setose, 4–5 long white setae in antero-ventral and postero-ventral rows, yellowish macrosetose: 1 anterior proximally, 2–3 antero-dorsal distally, 2–3 posterior distally; mes tibia orange to light brown, short white setose, yellowish macrosetose: 4 in 2 dorsal rows, 3 in 1 antero-ventral row, 3 in 1 postero-ventral row, distal tip with 5 long yellowish macrosetae; met coxa orange to light brown, white pubescent, white setose and yellowish macrosetose, anteriorly without any protuberance; met trochanter yellowish macrosetose, cylindrical, medially without any protuberance; met femur orange to light brown, short white setose, yellowish macrosetose: 6 in 1 anterior row, 6 in 1 antero-ventral row, 3–4 long in 1 postero-ventral row, 1 distal dorsally; met tibia orange to light brown, straight, short white setose, yellowish macrosetose: 5 in

1 anterior row, 4 in 1 antero-ventral row, 5 in 1 dorsal row, distal tip with 5 short yellowish macrosetae; proximal pro and mes tarsomere as long as following 2 tarsomeres combined, proximal met tarsomere longer than 2 following tarsomeres combined, proximal met tarsomere as wide as following tarsomeres; pro tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 short yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; mes tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 short yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; met tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 short yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; pulvilli well-developed (as long as claw); claw abruptly angled distally, pointed; empodium setiform, approximately ½ length of claw.

Wing: 3.2–4.1 mm.

Abdomen: shape compressed, T2–3 distinctly transversely rectangular (length to width ratio > 1:3), orange to light brown, tergites smooth, setae with small sockets only; T1 white setose, postero-laterally long white macrosetose, white pubescent, anterior ½, except laterally, membranous, dorsal surface smooth, without protuberances; T2–8 entirely sclerotised, orange to light brown, white pubescent: in dorsal view T2–7 appearing predominantly apubescent except laterally, in lateral view T2–7 appearing apubescent in posterior ½ except lateral margin, short white setose, long white setose antero-laterally on T2, marginal macrosetae absent from T2–8, medial macrosetae absent from T2–8; S1–8 orange to light brown, lightly grey pubescent, short white setose.

Female: T6–7 predominantly grey pubescent, T8 apubescent medially and posteriorly, setation directed dorsally; postero-paramedian T8 pores present, indistinct, opening not elevated above tergite surface; T8 without any internal apodeme anteriorly; T10 divided into 2 heavily sclerotised acanthophorite plates, with 6–8, light brown acanthophorite spines per plate; 3 spermathecae, all equally large, reaching anterior end of segment 5; common spermathecal duct short, not extending beyond tip of genital fork (S9, furca), individual spermathecal ducts short or long; spermathecal reservoirs spherical, heavily sclerotised; genital fork (S9, furca) formed by single, inverted V-shaped sclerite, median sclerite (at posterior tip) absent, anterior apodeme absent.

Male (Figs 60–61): T1–T7 and S1–S7 entire, T8 + S8 reduced to ring of sclerites; hypopygium orange to light brown, rotated by 180°; hypandrium well-developed, triangular, posterior margin with long postero-median projection; gonocoxal apodeme present, short, entirely confined to hypopygium.

Type locality: SOUTH AFRICA: *Northern Cape*: Kamieskroon, 30°12'00"S, 017°56'00"E (-30.20, 17.93).

Material examined. SOUTH AFRICA: *Northern Cape*: 5♀ 4♂ Kamieskroon, 30°12'00"S, 017°56'00"E, 1936-11-00, Museum Staff (1♂ Holotype SAM-DIP-A015480, SAM, Paratypes 1♂ NMSA-DIP-4767, NMSA, 5♀ SAM-DIP-A015481–SAM-DIP-A015483, SAM-DIP-A015486–SAM-DIP-A015487, SAM, 2♂ SAM-DIP-A015484–SAM-DIP-A015485, SAM).

Distribution, biodiversity hotspots, phenology and biology. Known only from the type locality in the Northern Cape of South Africa (Fig. 71). A rarely collected species known only from a single collecting event in 1936 (Table 1). The species is en-

demic to the Cape Floristic Region biodiversity hotspot. Adult flies are active in early summer in a winter rainfall region (Table 2). Nothing is known of the biology.

Microphontes safra Londt, 1994

http://zoobank.org/0F1497C1-868C-48B7-8816-D6415CC1ED97
Figs 3–4, 44–49, 64–65, 72

Microphontes safra Londt, 1994: 87.

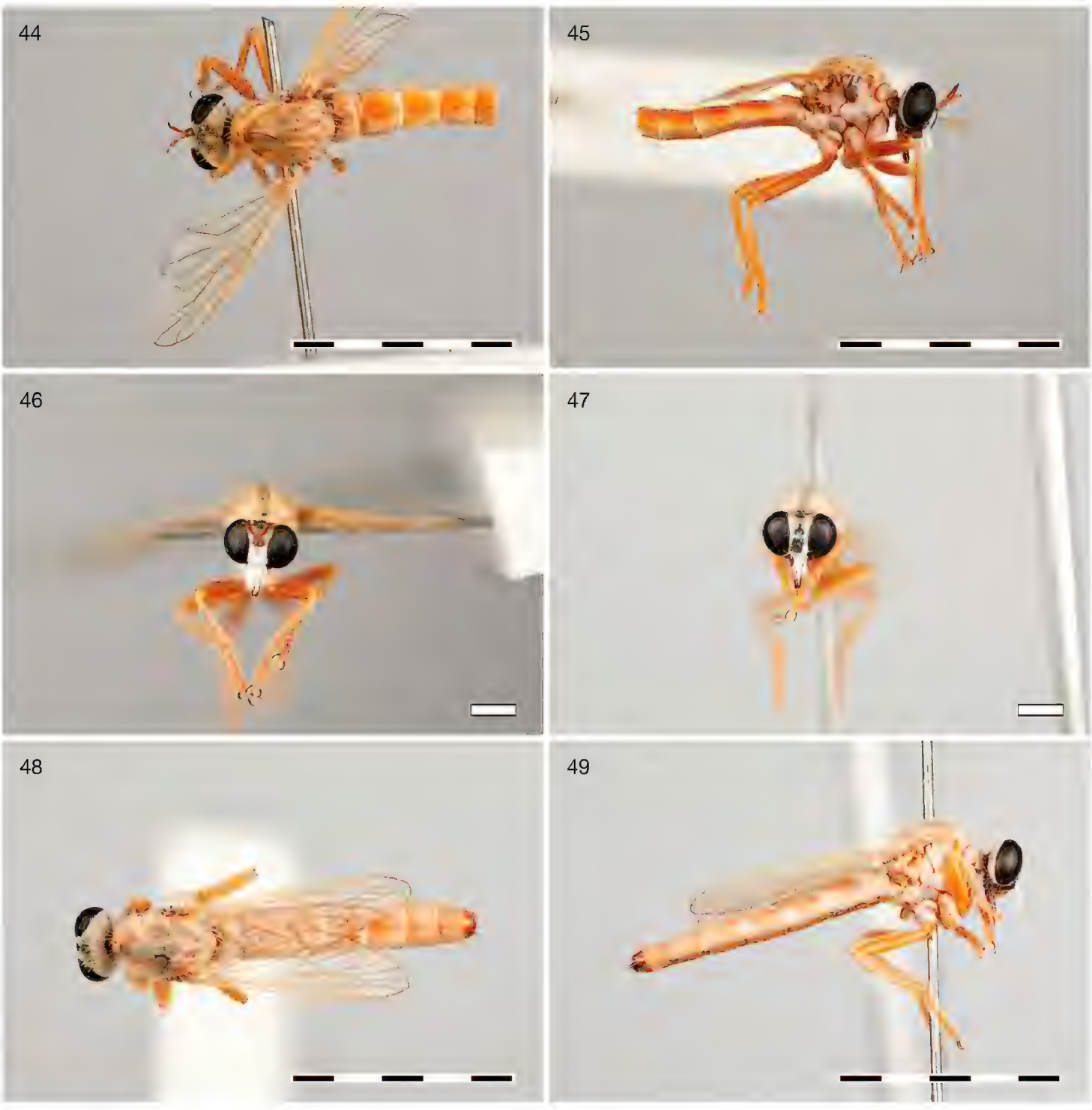
Diagnosis. The species is distinguished from congeners by the more or less square abdominal tergites, the short macrosetose dorsal anepisternum, the setose ante- and postpronotum, the overall orange colouration and white pubescence and the apubescent female abdominal tergite 8.

Redescription. *Head*: wider than high, brown; vertex and compound eyes at same level; facial swelling indistinct, only lower facial margin slightly developed, silver pubescent; mystax white macrosetose, restricted to lower facial margin, short, reaching tip of proboscis; ommatidia of same size; postgena posterior margin simple, smooth; frons (at level of antennal insertion) slightly diverging laterally, greyish-brown pubescent, light brown macrosetose; ocellar tubercle greyish-brown pubescent, light brown setose; vertex greyish-brown pubescent, yellowish to light brown macrosetose; median occipital sclerite (m ocp scl) with several yellowish macrosetose; postocular (pocl) setae slightly angled anteriorly distally, yellowish macrosetae; occiput predominantly grey pubescent, yellowish setose; compound eye posterior margin (in lateral view) straight or slightly curved throughout.

Proboscis and maxillary palpus: proboscis straight, brown; postmentum plate-like, straight, ventral margin entirely smooth, white setose ventrally; prementum circular, with dorso-median flange, asetose; labella reduced, fused to prementum only ventrally, only forming distal tip of proboscis, rounded; maxillary palpus orange, two-segmented, long yellowish setose, cylindrical; stipites fused medially, but with V-shaped indentation, apubescent, long white setose.

Antenna: orange, lightly grey pubescent; scape 1.5× as long as pedicel, short and long yellowish setose and macrosetose ventrally; pedicel short yellowish setose ventrally and dorsally; postpedicel cylindrical (same diameter throughout), 1.5× as long as scape and pedicel combined, asetose; stylus comprised of 1 element, 0.28× as long as postpedicel, asetose; apical seta-like sensory element situated apically on stylus.

Thorax: brown, postpronotal lobes and lateral scutum orange to light brown; prosternum white pubescent, separated from proepisternum, square to rectangular in shape (straight dorsally); proepisternum white pubescent, long yellowish macrosetose; cervical sclerite long white setose; antepronotum white pubescent, short yellowish setose and long yellowish macrosetose; postpronotum white pubescent, predominantly yellowish setose, long yellowish macrosetose antero-laterally, rarely long yellowish macrosetose sub-laterally and laterally; postpronotal lope short and long yellowish macrosetose; pleuron white pubescent; proepimeron short yellowish macrosetose anteriorly;



Figures 44–49. *Microphontes safra*: **44** ♂ Holotype (NMSA-DIP-4769), dorsal (Morphbank #861874) **45** same, lateral (#861876) **46** same, head anterior (#861878) **47** ♀ Paratype (NMSA-DIP-74618), head anterior (#861881) **48** same, dorsal (#861883) **49** same, lateral (#861885). Scale bars: 5 mm (**44–45, 48–49**), 1 mm (**46–47**).

anepisternum short white setose dorsally, supero-posteriorly short white setose (indistinguishable from other dorsal anepisternal setation); anterior basalare short yellowish setose dorsally, posterior basalare asetose; anepimeron asetose, katepisternum predominantly asetose, postero-dorsally yellowish setose, katepimeron asetose, katatergite white setose and long yellowish macrosetose, meron + metanepisternum asetose, metakatepisternum asetose, metepimeron asetose, anatergite asetose; scutum white to greyish pubescent, scutum setation: short yellowish setose, setae with small sockets, 2 npl setae, 2–3 spa setae, 2 pal setae, 3–4 long yellowish postsutural dc macrosetae, acr setae short yellowish presuturally and postsuturally, median posterior scutum (between dc setae) asetose; scutellum grey pubescent, ds sctl setae absent, ap sctl setae present, 4–6 long yellowish macrosetae; postmetacoxal area entirely membranous.

Leg: orange to light brown, apubescent, all setae circular in cross section; pro coxa orange to light brown, white pubescent, white setose and macrosetose; pro femur orange to light brown, short white setose, yellowish macrosetose: 1 antero-dorsal proximally, 1 antero-dorsal distally, 2 dorsal distally; pro tibia orange to light brown, short white setose, yellowish macrosetose: 4 in 1 antero-dorsal row, 4 in 1 dorsal row, 4 in 1 posterior row, 3 in 1 postero-ventral row, distal tip with 3–4 long yellowish macrosetae; mes coxa orange to light brown, white pubescent, yellowish macrosetose; mes femur orange to light brown, short white setose, yellowish macrosetose: 1 antero-dorsal proximally, 1 antero-dorsal distally, 1–2 dorsal distally; mes tibia orange to light brown, short white setose, yellowish macrosetose: 4 in 2 dorsal rows, 3 in 1 antero-ventral row, 3 in 1 postero-ventral row, distal tip with 5 long yellowish macrosetae; met coxa orange to light brown, white pubescent, white setose and yellowish macrosetose, anteriorly without any protuberance; met trochanter yellowish macrosetose, cylindrical, medially without any protuberance; met femur orange to light brown, short white setose, yellowish macrosetose: 2–3 in 1 anterior row, 2 distal dorsally, 3 apical dorsally; met tibia orange to light brown, straight, short white setose, yellowish macrosetose: 4 in 1 anterior row, 3 in 1 antero-ventral row, 4 in 1 dorsal row, distal tip with 6 long yellowish macrosetae; proximal pro, mes and met tarsomeres longer than following 2 tarsomeres combined, proximal met tarsomere as wide as following tarsomeres; pro tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 long yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; mes tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 long yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; met tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 long yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; pulvilli well-developed (as long as claw); claw abruptly angled distally, pointed; empodium setiform, approximately ½ length of claw.

Wing: 4.1–5.0 mm.

Abdomen: shape regular, T2–3 somewhat square (length to width ratio = 1:1.2), orange to light brown, tergites smooth, setae with small sockets only; T1 white setose, postero-laterally long white macrosetose, grey pubescent, anterior ¼, except laterally, membranous, dorsal surface smooth, without protuberances; T2–8 entirely sclerotised, orange to light brown, white pubescent: in dorsal view appearing apubescent medially (area broader proximally), in lateral view appearing apubescent on entire dorsal surface (only lateral-most margin pubescent), short white setose, long white setose antero-laterally on T2, marginal macrosetae absent from T2–8, medial macrosetae absent from T2–8; S1–8 orange to light brown, lightly grey pubescent, short white setose.

Female: T6–7 grey pubescent, T8 apubescent, setation directed anteriorly on T6–7 and dorsally on T8; postero-paramedian T8 pores present, indistinct, opening not elevated above tergite surface; T8 without any internal apodeme anteriorly; T10 divided into 2 heavily sclerotised acanthophorite plates, with 6, dark brown acanthophorite spines per plate; 3 spermathecae, all equally large, reaching posterior end of segment 6; common spermathecal duct very long, extending well-beyond tip of genital fork (S9, furca), individual spermathecal ducts short; spermathecal reservoirs formed by more or less expanded ducts to sac-shaped reservoir, heavily sclerotised; genital fork (S9, furca)

formed by single, inverted Y-shaped sclerite, median sclerite (at posterior tip) absent, anterior apodeme present, short plate-like apodeme.

Male (Figs 64–65): T1–T8 and S1–S8 entire (without modifications); hypopygium dark brown, rotated by 90°; hypandrium well-developed, triangular, posterior margin with long postero-median projection; gonocoxal apodeme present, short, entirely confined to hypopygium; phallus very short, tip at level of origin of gonostyli, 1 phallic prong, tip pointed, without any protuberance.

Type locality: NAMIBIA: *Hardap*: Aandster Farm, 25°21'34"S, 016°06'04"E (-25.35944, 16.10111).

Material examined. NAMIBIA: *Hardap*: 2♀ 1♂ Aandster Farm, 25°21'34"S, 016°06'04"E, 1000 m, 1974-02-16, vegetated dune and grassland, Irwin, M. (1♂ Holotype NMSA-DIP-4769, 2♀ Paratypes NMSA-DIP-74617, NMSA-DIP-74618, NMSA); 1♂ Aandster Farm, 1974-02-17, Lyneborg, L. (Paratype NHMD289337, ZMUC); 1♂ Namib-Skeleton Coast National Park, Sesriem, Elim Dune, 24°27'28"S, 015°46'37"E, 826 m, 2012-02-09, dune, perching on sand, Dikow, T. (USNMENT00832231, USNM).

Distribution, biodiversity hotspots, phenology and biology. Known from two localities in Namibia (Fig. 72). A rarely collected species known only from three collecting events (Table 1). Adult flies are active in summer in a summer rainfall region on the eastern edge of the Namib Sand Sea (Table 2). Not known to occur in any biodiversity hotspot. Biological data available pertain to the habitat and perching behaviour. All specimens have been collected on partly vegetated sand dunes (Figs 3–4) and data for one specimen indicate that the species perches directly on the sand.

Remarks. A photograph of this species was erroneously included by Londt and Dikow (2017) (their figures 91–92, specimen USNMENT00832231) under the genus *Afroholopogon* Londt, 1994, which was a misidentification by T. Dikow at the time. The original type series of *M. safra* collected on the Aandster farm (now part of the NamibRand Nature Reserve) originates from two collecting events on a joint expedition by Drs Mike Irwin (3 specimens) and Leif Lyneborg (1 specimen). These specimens were collected on separate dates and, at separate sites on the Aandster farm as co-ordinates in the quarter-degree system (Larsen et al. 2009), were provided on the label as 2516Ac (M. Irwin) and 2515Bd (L. Lyneborg). Since it is impossible to decipher the exact location of the dunes from these co-ordinates, we plot a single locality (25°21'34"S, 016°06'04"E) for all specimens.

Microphontes whittingtoni Londt, 1994

http://zoobank.org/D603844F-B297-4798-B33D-60111F75B63C
Figs 50–55, 66–67, 72

Microphontes whittingtoni Londt, 1994: 87.

Diagnosis. The species is distinguished from congeners by the small size with a wing length of 3.1–3.7 mm, distinctly wider than long and transversely rectangular abdomi-

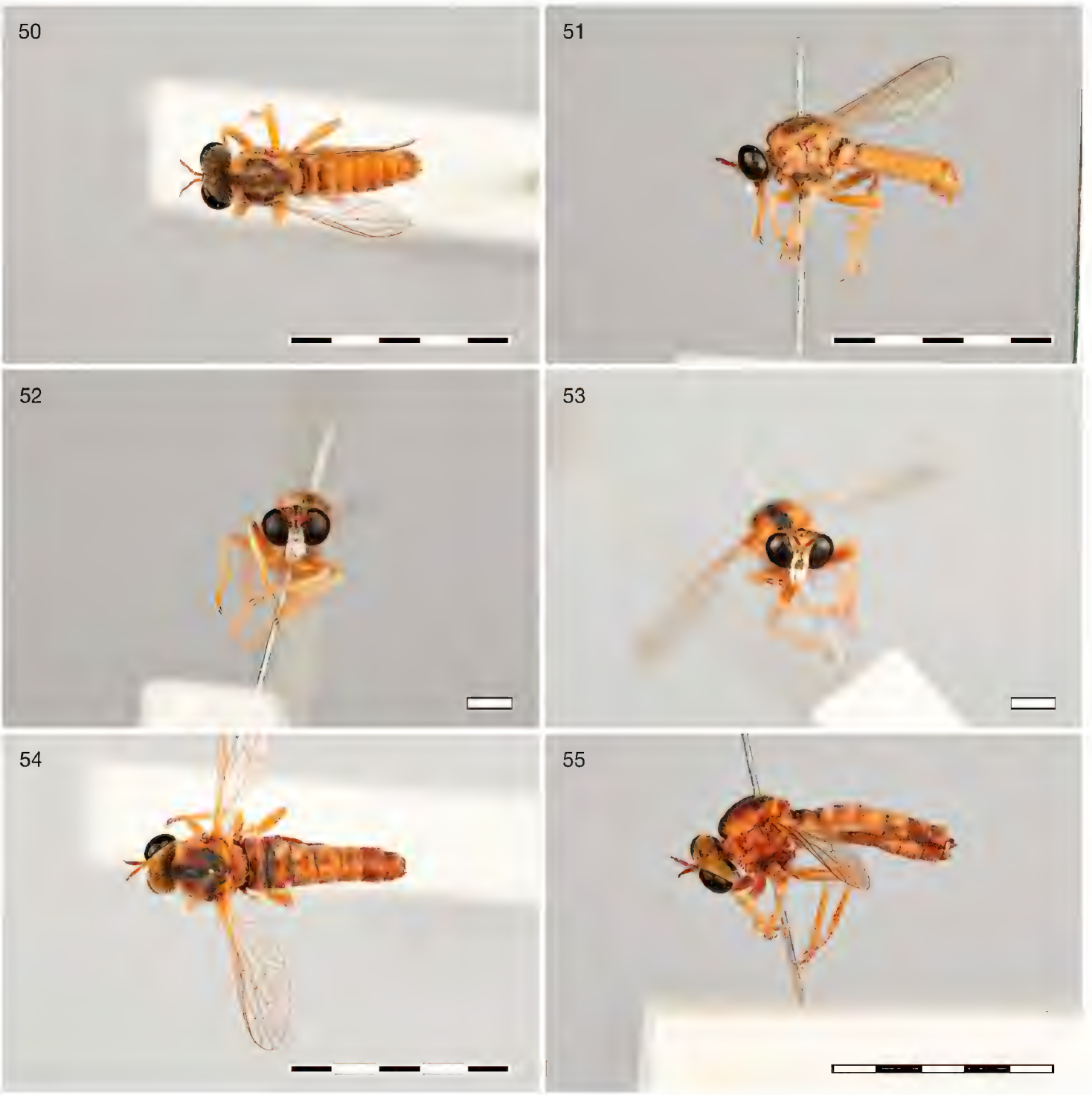
nal tergites, entirely setose postpronotal lobes and dorsal and posterior anepisternum (no macrosetae) and features of the male terminalia such as the short postero-median projection on the hypandrium and shape of the gonostyli.

Redescription. *Head*: wider than high, brown; vertex and compound eyes at same level; facial swelling indistinct, only lower facial margin slightly developed, silver pubescent; mystax white macrosetose, restricted to lower facial margin, short, reaching tip of proboscis; ommatidia of same size; postgena posterior margin simple, smooth; frons (at level of antennal insertion) slightly diverging laterally, grey pubescent, yellowish setose; ocellar tubercle light brown pubescent, light brown setose; vertex greyish-light brown pubescent, yellowish to light brown macrosetose; median occipital sclerite (m ocp scl) with several yellowish macrosetose; postocular (pocl) setae slightly angled anteriorly distally, yellowish macrosetae; occiput predominantly grey pubescent, yellowish setose; compound eye posterior margin (in lateral view) straight or slightly curved throughout.

Proboscis and maxillary palpus: proboscis straight, brown; postmentum plate-like, straight, ventral margin entirely smooth, white setose ventrally; prementum circular, with dorso-median flange, asetose; labella reduced, fused to prementum only ventrally, only forming distal tip of proboscis, rounded; maxillary palpus brown, two-segmented, long yellowish setose, cylindrical; stipites fused medially, but with V-shaped indentation, apubescent, long white setose.

Antenna: light brown, lightly grey pubescent; scape 1.5× as long as pedicel, short and long yellowish setose and macrosetose ventrally; pedicel short yellowish setose dorsally and long yellowish macrosetose ventrally; postpedicel cylindrical (same diameter throughout), approximately 2× as long as scape and pedicel combined, asetose; stylus comprised of 1 element, 0.14× as long as postpedicel, asetose; apical seta-like sensory element situated apically in cavity on stylus.

Thorax: light brown, scutum with median longitudinal stripe and shorter sublateral longitudinal stripes brown; prosternum white pubescent, separated from proepisternum, square to rectangular in shape (straight dorsally); proepisternum white pubescent, long yellowish macrosetose; cervical sclerite long yellowish setose; antepronotum white pubescent, short yellowish setose medially, long and weakly yellowish macrosetose laterally; postpronotum white pubescent, long yellowish setose medially and sub-laterally, long and weakly yellowish macrosetose laterally; postpronotal lope long yellowish setose; pleuron white pubescent; proepimeron long white setose anteriorly; anepisternum long yellowish setose dorsally (setae directed dorsally), long yellowish setose postero-medially (setae directed posteriorly), supero-posteriorly long yellowish setose (indistinguishable from other dorsal anepisternal setation); anterior basalare long yellowish setose medially, posterior basalare asetose; anepimeron asetose, katepisternum asetose, katepimeron asetose, katatergite long yellowish macrosetose, meron + metanepisternum asetose, metakatepisternum asetose, metepimeron asetose, anatergite asetose; scutum white to greyish pubescent, scutum setation: long yellowish setose, setae with small sockets, 1 npl setae, 1 spa setae, 1–2 pal setae, 2–3 long yellowish postsutural dc macrosetae, acr setae long yellowish presuturally and post-



Figures 50–55. *Microphontes whittingtoni*: **50** ♂ Holotype (NMSA-DIP-4777), dorsal (Morphbank #861895) **51** same, lateral (#861897) **52** same, head anterior (#861899) **53** ♀ Paratype (NMSA-DIP-74619), head anterior (#861902) **54** same, dorsal (#861904) **55** same, lateral (#861906). Scale bars: 5 mm (**50–51, 54–55**), 1 mm (**52–53**).

suturally, median posterior scutum (between dc setae) long yellowish setose, setae directed anteriorly; scutellum white pubescent, ds sctl setae present, long yellowish setae, ap sctl setae present, 6–8 long yellowish macrosetose; postmetacoxal area entirely membranous.

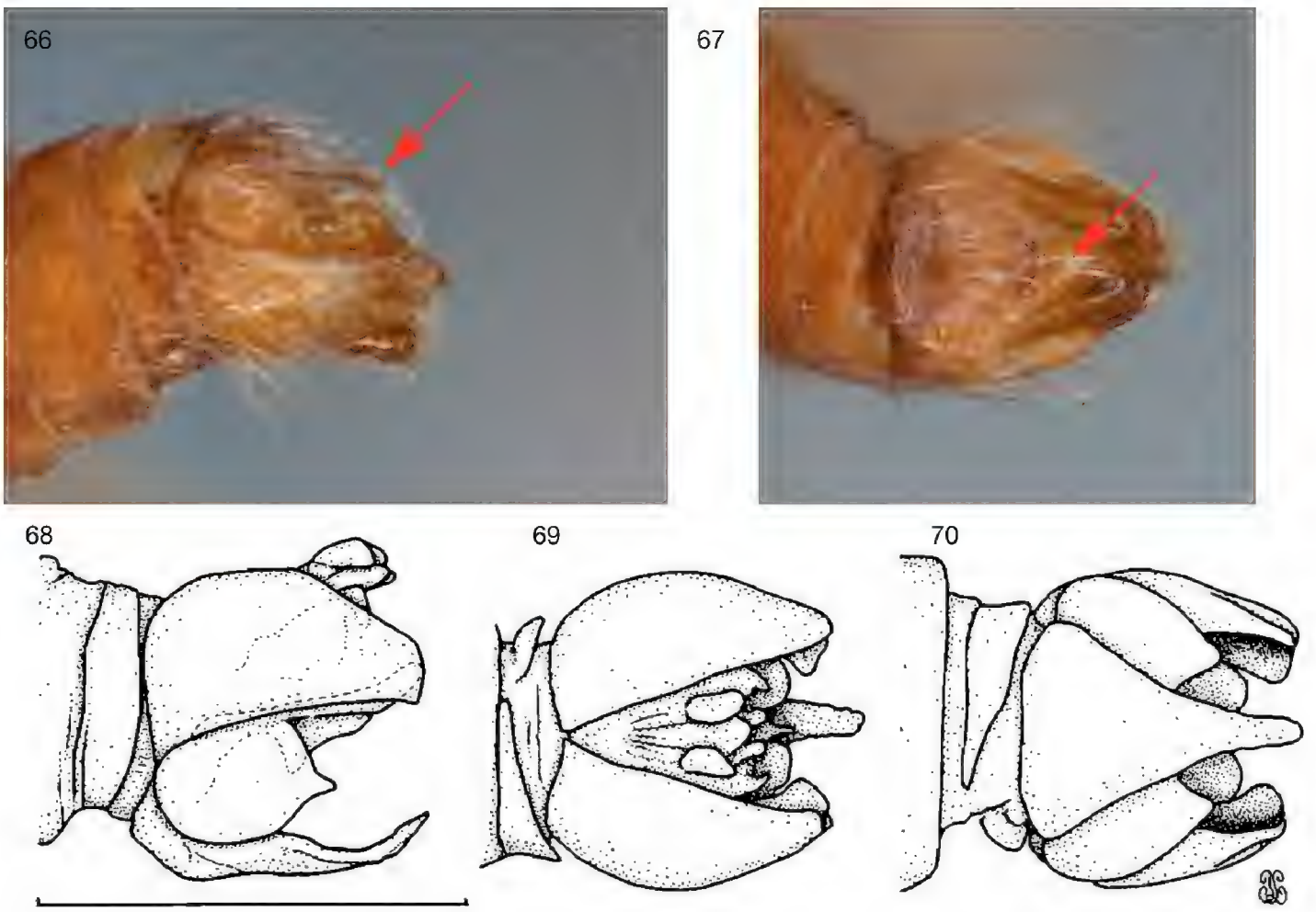
Leg: orange to light brown, apubescent, all setae circular in cross section; pro coxa orange to light brown, white pubescent, white setose and macrosetose; pro femur orange to light brown, short white setose, white macrosetose: 2–3 postero-dorsal distally; pro tibia orange to light brown, short white setose, yellowish macrosetose: 4 in 1 antero-dorsal row, 4 in 1 dorsal row, 4 in 1 posterior row, 4 in 1 postero-ventral row, distal tip with 3–4 long yellowish macrosetae; mes coxa brown, white pubescent,

Figures 56–61. Photographs of ♂ terminalia (as in life rotated 180°): **56** *Microphontes ericfisheri* sp. n. (Holotype, USNMENT01115122), lateral (image flipped horizontally showing right side, Morphbank #861789) **57** same, ventral (#861791) **58** *Microphontes jasonlondti* sp. n. (Holotype, NMSA-DIP-4768), lateral (#861822) **59** same, ventral (#861824) **60** *Microphontes megoura* (Holotype, NMSA-DIP-4768), lateral (#861868) **61** same, ventral (#861870). Magnification: 120×.

white macrosetose; mes femur orange to light brown, short white setose, yellowish macrosetose: 2 anterior proximally and medially, 2–3 anterior distally, 4 posterior distally; mes tibia orange to light brown, short white setose, yellowish macrosetose: 5 in 1 dorsal row, 3 in 1 anterior row, 5 in 1 antero-dorsal row, 5 in 1 antero-ventral row, 6 in 1 postero-ventral row, distal tip with 8 long yellowish macrosetae; met coxa orange

Figures 62–65. Photographs of ♂ terminalia (as in life rotated 90°): **62** *Microphontes gaiophanes* sp. n. (Paratype, USNMENT01384082), lateral (top = ventral, Morphbank #861913) **63** same, ventral (#861915, image rotated 180°) **64** *Microphontes safra* (USNMENT00832231), lateral (top = dorsal, #861889) **65** same, ventral (#861891). Magnification: 120×.

to light brown, white pubescent, white setose and macrosetose, anteriorly without any protuberance; met trochanter yellowish macrosetose, cylindrical, medially without any protuberance; met femur orange to light brown, short white setose, yellowish macrosetose: 2–3 in 1 anterior row, 2 distal dorsally, 3 apical dorsally; met tibia orange to light brown, straight, short white setose, yellowish macrosetose: 4 in 1 anterior row, 3 in 1 antero-ventral row, 4 in 1 dorsal row, distal tip with 5 short yellowish macrosetae; proximal pro and mes tarsomere as long as following 2 tarsomeres combined, proximal met tarsomere longer than 2 following tarsomeres combined, proximal met tarsomere as wide as following tarsomeres; pro tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 short yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; mes tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 short yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; met tarsomeres 1–5 white setose dorsally, tarsomeres 1–4 short yellowish macrosetose disto-laterally and disto-dorsally, tarsomere 5 weakly yellowish macrosetose distally; pulvilli well-developed (as long as claw); claw abruptly angled distally, pointed; empodium setiform, approximately ½ length of claw.



Figures 66–70. Photographs of ♂ terminalia (as in life rotated 180°) and illustrations from Londt (1994, figures 51–53): **66** *Microphontes whittingtoni* (Holotype, NMSA-DIP-4777), lateral (Morphbank #861908) **67** same, ventral (#861910) **68** *Microphontes kryphios* sp. n. (Holotype, NMSA-DIP-74620), lateral **69** same, dorsal **70** same, ventral. Arrows point to tip of postero-median projection of hypandrium. Magnification: 120× (**66–67**), Scale bars: 1 mm (**68–70**).

Wing: 3.1–3.7 mm.

Abdomen: shape compressed, T2–3 distinctly transversely rectangular (length to width ratio > 1:3), orange to light brown, tergites smooth, setae with small sockets only; T1 white setose, postero-laterally long white macrosetose, white pubescent, anterior ½, except laterally, membranous, dorsal surface smooth, without protuberances; T2–8 entirely sclerotised, orange to light brown, white pubescent: in dorsal view T2–7 appearing predominantly apubescent except laterally, in lateral view T2–7 appearing apubescent in posterior ½ except lateral margin, short white setose, long white setose antero-laterally on T2, marginal macrosetae absent from T2–8, medial macrosetae absent from T2–8; S1–8 orange to light brown, lightly grey pubescent, short white setose.

Female: T6–8 grey pubescent, setation directed anteriorly on T6–7 and dorsally on T8; postero-paramedian T8 pores present, indistinct, opening not elevated above tergite surface; T8 with internal rectangular apodeme (entirely fused to T) anteriorly; T10 divided into 2 heavily sclerotised acanthophorite plates, with 6–7, light brown acanthophorite spines per plate; 3 spermathecae, all equally large, reaching posterior end of segment 6; individual spermathecal ducts long; spermathecal reservoirs spheri-

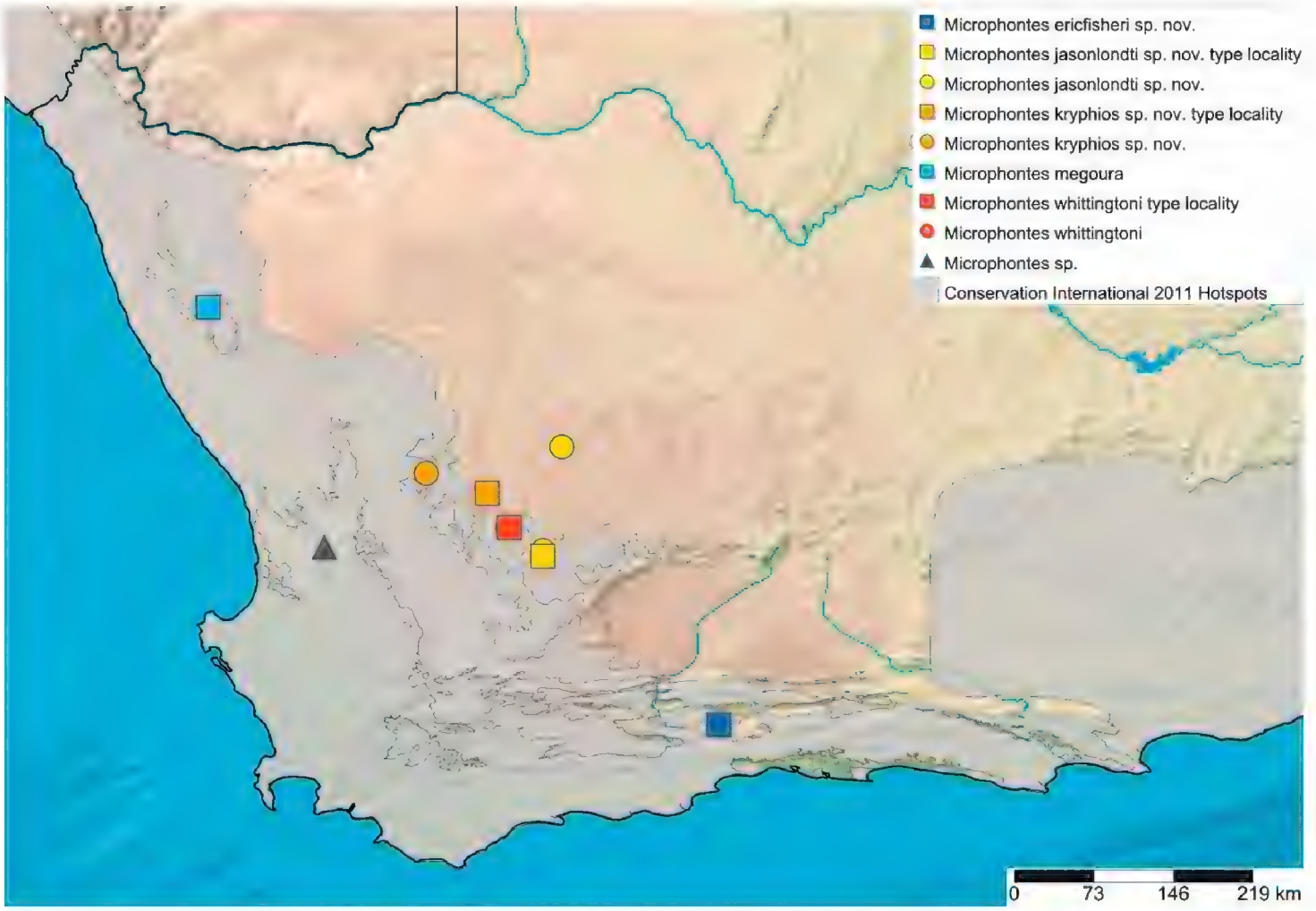


Figure 71. Map of south-western South Africa with elevational relief, Biodiversity Hotspots (*sensu* Conservation International) and distribution of *Microphontes* species occurring in South Africa (SimpleMappr 10598). Map data available in Google Earth KML file 10598 and also through GBIF (data-set http://www.gbif.org/dataset/4c13483d-a2ac-4c61-9087-c4e1a3c7b91d, DOI https://doi.org/10.15468/m2vwyh).

cal, heavily sclerotised; genital fork (S9, furca) formed by single, inverted V-shaped sclerite, median sclerite (at posterior tip) absent, anterior apodeme absent.

Male (Figs 66–67): T1–T7 and S1–S7 entire, T8 + S8 reduced to ring of sclerites; hypopygium orange to light brown, rotated by 180°; hypandrium well-developed, triangular, posterior margin with short postero-median projection; gonocoxal apodeme present, short, entirely confined to hypopygium.

Type locality: SOUTH AFRICA: *Northern Cape*: Visrivier (23 km SE Middelpos), 32°01'00"S, 020°25'00"E (-32.01667, 20.41667).

Material examined. SOUTH AFRICA: *Northern Cape*: 1♀ 2♂ Visrivier, 23 km SE Middelpos, 32°01'00"S, 020°25'00"E, 1990-11-28, Whittington, A., Londt, J. (1♂ Holotype NMSA-DIP-4777, Paratypes 1♀ NMSA-DIP-74619, 1♂ NMSA-DIP-74620, NMSA); 1♀ Fish River bridge, 23 km SE Middelpos, 32°01'25"S, 020°24'24"E, 1145 m, 2008-11-18, sandy riverine scrub area, Londt, J., Londt, A. (NMSA-DIP-74484, NMSA).

Distribution, biodiversity hotspots, phenology and biology. Known from two nearby localities in the Northern Cape of South Africa (Fig. 72). A rarely collected species known only from two collecting events (Table 1). Adult flies are active in early summer in a winter rainfall region (Table 2). The species is endemic to the Succulent

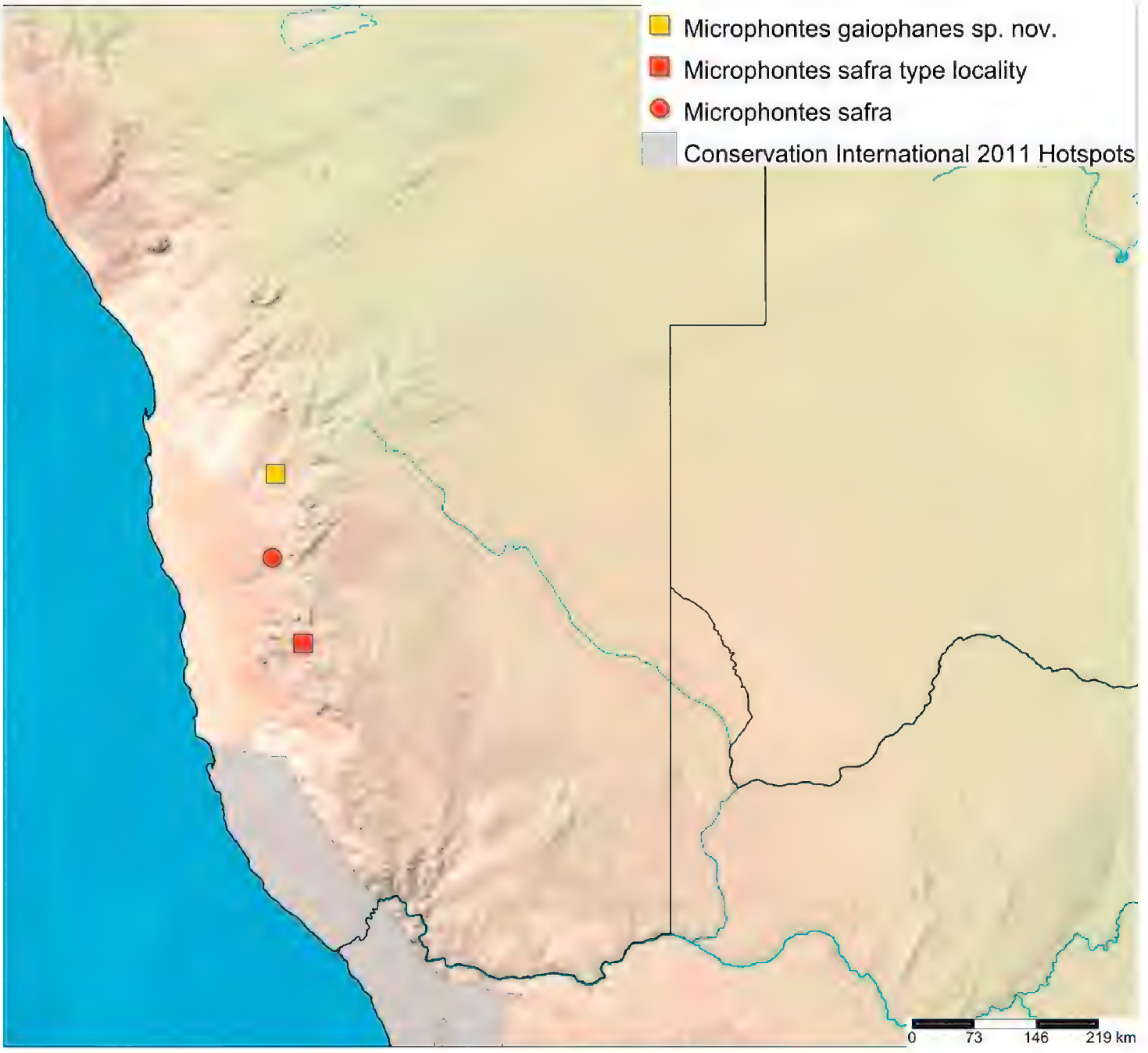


Figure 72. Map of Namibia with elevational relief, Biodiversity Hotspots (*sensu* Conservation International) and distribution of *Microphontes* species occurring in Namibia (SimpleMappr 10599). Map data available in Google Earth KML file 10599 and also through GBIF (data-set http://www.gbif.org/dataset/4c13483d-a2ac-4c61-9087-c4e1a3c7b91d, DOI https://doi.org/10.15468/m2vwyh).

Karoo biodiversity hotspot. Biological data available pertain to the habitat and indicate that the species occurs in sandy habitats along rivers.

Remarks. The boundaries of this species have been redefined based on the study of all primary and secondary type specimens originally studied by Londt (1994) and additional specimens collected in the south-western Northern Cape Province. We postulate that *M. whittingtoni* represents a group of morphologically similar species and we have split the type series into three species. Londt (1994) cleared the male terminalia of two paratype specimens and illustrated one of them in his figures 51–53 (see Figs 68–70). The holotype of *M. whittingtoni* does not have the long postero-median projection on the hypandrium (see Fig. 66) that was illustrated by Londt (1994) based on the paratype from 23 km N Middelpos (Fig. 68), which now represents the holotype of *M. kryphios* sp. n. (see also Remarks under *M. jasonlondti* sp. n.).

Key to species of Microphontes

1 Dorsal anepisternum long yellowish setose only; frons laterally setose only; T2–3 distinctly wider than long and transversely rectangular (length to width ratio 1:1.5 to >1:3, Figs 26, 38) **3**

– Dorsal anepisternum short yellowish macrosetose; frons laterally macrosetose; T2–3 only slightly wider than long and somewhat square (length to width ratio = 1:1.2, Fig. 11) **2**

2 Crossvein *r-m* situated in distal half of cell *d* (Fig. 11); female T8 grey pubescent (Fig. 24); postpronotum extensively macrosetose (setose only sublaterally); 6–8 discal scutellar setae ..... ***M. gaiophanes* sp. n.**

– Crossvein *r-m* situated in proximal half of cell *d* (Fig. 44); female T8 apubescent (Fig. 48); postpronotum extensively setose (macrosetose only anterolaterally); 4–6 discal scutellar setae ..... ***M. safra***

3 Postpronotal lobes long yellowish setose and longer yellowish macrosetose anteriorly (macrosetae directed antero-dorsally) **5**

– Postpronotal lobes only long yellowish setose (no longer antero-dorsally directed macrosetae anteriorly) **4**

4 Orange to light brown-coloured species with predominantly white pubescence (Fig. 51); *r-m* situated in proximal half of cell *d* (Fig. 54); male hypandrium with short postero-median projection (Fig. 66) ..... ***M. whittingtoni***

– Brown-coloured species with predominantly light brown pubescence (Fig. 6); *r-m* situated at centre of cell *d* (Fig. 6); male hypandrium with long postero-median projection (almost reaching posterior tip of epandrium, Fig. 56) ..... ***M. ericfisheri* sp. n.**

5 T2–3 only somewhat wider than long (length to width ratio = 1:1.5–1:2, Fig. 26); 12–16 apical scutellar macrosetae; male gonocoxite long, extending beyond midpoint of epandrium in lateral view (Fig. 58) ..... ***M. jasonlondti* sp. n.**

– T2–3 distinctly wider than long and transversely rectangular (length to width ratio > 1:3, Fig. 38); 6–10 apical scutellar macrosetae; male gonocoxite short, not reaching midpoint of epandrium in lateral view (Fig. 60) **6**

6 Anepisternum long yellowish setose postero-medially (no macrosetae); tip of epandrium simple, straight and blunt (Fig. 68) ..... ***M. kryphios* sp. n.**

– Anepisternum long yellowish macrosetose postero-medially; tip of epandrium distinctly bent ventrally and broad (Figs 60–61) ..... ***M. megoura***

An online, illustrated version of this key is available at http://keys.lucidcentral.org/keys/phoenix/microphontes/.

Discussion

Microphontes is a rarely encountered genus of assassin flies with currently only 44 specimens available in natural history collections from throughout the western parts

of Southern Africa (Table 1, Figs 5, 71–72). Species of *Microphontes* are very similar in external morphological features and are difficult to distinguish. Several specimens studied were greasy making identification difficult as the pubescence pattern could not be properly studied. A single specimen that appears to be teneral has been studied that could represent an undescribed species. The distribution of this specimen is plotted in Fig. 71 and the occurrence data are as follows: 1♂ South Africa: Western Cape: Willie Nel Farm, 11 km W Clanwilliam, 32°10'47"S, 018°53'29"E, 1999-11-30, Malaise trap, Parker, F. (INHS-Diptera-3932, INHS).

Male flight pattern in *M. gaiophanes* sp. n.

The peculiar flight pattern of *M. gaiophanes* sp. n. males with a roller coaster-like up-and-down movement in open spaces on partly vegetated sand dunes (Figs 1–2) is not used to capture prey although it should be noted that no prey records exist. Our hypothesis is that this pattern is an advertising flight to attract females, which are perching or resting close to the larger vegetation on the sand dune. Lavigne and Holland (1969) and Dennis and Lavigne (1975) describe a very similar undulating flight behaviour, termed searching flights, for *Efferia staminea* (Williston, 1885) and *Proctacanthus micans* Schiner, 1867 (both Asilinae) and *Scleropogon neglectus* (Bromley, 1931) (Stenopogoninae), for example. It has more recently been described for *Diogmites crudelis* Bromley, 1936 (Dasypogoninae) by Dennis (2015). These published observations include three different subfamily taxa of rather large assassin flies, but this behaviour has not been observed in smaller robber flies possibly due to the difficulty in following smaller flies in the field (pers. comm. S. Dennis).

Morphological similarities

Species are, in general, morphologically very similar, but can be placed in two groups. *M. gaiophanes* sp. n. and *M. safra* are distinct in a number of features from all other species and are also currently representing the northernmost species. Both species share the square abdominal tergites making the abdomen longer than the wings (Figs 11, 15, 48), the macrosetose dorsal anepisternum, the laterally macrosetose frons, the ♂ terminalia rotated by 90° (Figs 62, 64), the entire development of ♂ T9 and S9 (Figs 17–19) and the ♂ terminalia essentially being closed in ventral view (epandrium, gonocoxite and hypandrium being tightly associated, Figs 63, 65).

The remaining five species have a shorter abdomen with *M. jasonlondti* sp. n. having somewhat compressed abdominal tergites 2–3 (length to width ratio = 1:1.5–1:2, Figs 26, 30) and *M. ericfisheri* sp. n., *M. kryphios* sp. n., *M. megoura* and *M. whittingtoni* having compressed abdominal tergites 2–3 (length to width ratio > 1:3, Figs 6, 36, 38, 42, 50 and 54), a setose dorsal anepisternum, a laterally setose frons, the ♂ terminalia rotated by 180° (Figs 56, 58, 60, 66), the ♂ T9 and S9 reduced to a narrow sclerite that is partially rotated (Figs 68–70) and "open" ♂ terminalia with easily visible gonostyli in lateral and ventral views (Figs 56–61).

Some taxonomists would consider these differences to provide evidence for splitting the taxa into two genera. We keep all seven species in a single genus as morphological dissimilarity does not necessarily reflect evolutionary history and we did not conduct a phylogenetic analysis to postulate apomorphic features and establish the sister-group to *Microphontes*. We hope that future research can shed light on the relationships of the above and potentially many new species and such new data might provide evidence to the evolutionary history of *Microphontes* species.

Unique morphological features in females

Females of *Microphontes* have unique morphological structures on tergite 8. A pair of distinct pores is situated paramedially in the posterior 1/4 of tergite 8 (Figs 21–22, 24–25). These pores are raised in *M. gaiophanes* sp. n. and smaller, not raised as well as less conspicuous in *M. jasonlondti* sp. n., *M. kryphios* sp. n., *M. megoura*, *M. safra* and *M. whittingtoni* (females of *M. ericfisheri* sp. n. are unknown). These structures are very difficult to see in pinned and dried specimens even at high magnification under a stereo microscope, but easily viewable in cleared and macerated specimens (even at lower magnification). The function of these pores is unclear and they could be interpreted to be glandular pores for secretion of specific chemicals. To our knowledge, structures such as these have not been reported for Asilidae and we term them here postero-paramedian T8 pores.

Seasonal incidence

Species of *Microphontes* have been collected in the Southern Hemisphere spring to summer (Table 2). *M. ericfisheri* sp. n. is restricted in imago flight activity to summer (December), *M. gaiophanes* sp. n. to spring (September), *M. jasonlondti* sp. n., *M. kryphios* sp. n., *M. megoura* and *M. whittingtoni* to early summer (November) and *M. safra* to late summer (February).

Biodiversity hotspots

Two species, *M. ericfisheri* sp. n. and *M. whittingtoni*, occur in and are endemic to the Succulent Karoo biodiversity hotspot sensu Conservation International (Fig. 72). *M. jasonlondti* sp. n. and *M. kryphios* sp. n. occur within the same hotspot, but have also been collected outside of it in the adjacent Nama Karoo biome. *M. megoura* occurs in and is endemic to the Cape Floristic Region biodiversity hotspot (Fig. 72). The other two species, *M. gaiophanes* sp. n. and *M. safra*, lie well outside any hotspot in the Namib Desert (Fig. 72). The unidentified specimen from Willie Nel Farm (32°10'47"S, 018°53'29"E) occurs within the Cape Floristic Region hotspot (Fig. 71).

Acknowledgements

We would like to thank the museum curators who made specimens available through loans. We would also like to graciously acknowledge the U.S. National Science Foundation for funding the Research Experience for Undergraduates site grant at the NMNH entitled Natural History Research Experience (NHRE) (OCE 1560088; PI E. Cottrell, Co-PI E. Hunt). We thank Gene Hunt, Virginia Power and Liz Cottrell for their constant support during the administration of the NHRE programme. We also acknowledge field work support to the junior author through a Field Dreams award from the Field Museum of Natural History, Chicago, Illinois, under a project entitled, "Exploring enigmatic flies in the Namib desert" (2012), the NMNH for a project entitled, "Novel morphological data to decipher the character and life history evolution and diversification of Asiloidea and Nemestrinoidea flies" (2017), and the Global Genome Initiative for a project entitled, "Asiloid flies in the Nama Karoo and comparative phylogenomics" (2015). John Hash (NMNH) is thanked for taking the photographs of female and male terminalia. Furthermore, we thank the Namibian Ministry of Environment and Tourism and CapeNature (Western Cape, South Africa) for providing collecting and export permits in support of the field work in Namibia and South Africa. We thank Rodrigo Vieira and Steve Dennis for their constructive comments during peer review and suggestions on biological literature.

References

Cumming JM, Wood DM (2017) 3. Adult morphology and terminology. In: Kirk-Spriggs AH, Sinclair BJ (Eds) Manual of Afrotropical Diptera, vol. 1. Introductory chapters and keys to Diptera families. Suricata 4, SANBI, Pretoria, 89–133.

Dennis DS (2015) Ethology of *Diogmites crudelis* Bromley, 1936 (Diptera: Asilidae) in Northeastern Florida, U.S.A. Journal of Entomological Research Society 17(1): 23–44. URL http://entomol.org/journal/index.php/JERS/article/view/720/346

Dennis DS, Lavigne RJ (1975) Comparative behavior of Wyoming robber flies II. Science Monograph University of Wyoming 30: 1–68.

Dikow T (2009) Phylogeny of Asilidae inferred from morphological characters of imagines (Insecta: Diptera: Brachycera: Asiloidea). Bulletin of the American Museum of Natural History 319: 1–175. https://doi.org/10.1206/603.1

Larsen R, Holmen T, Prager SD, Maliti H, Røskaft E (2009) Using the extended quarter degree grid cell system to unify mapping and sharing of biodiversity data. African Journal of Ecology 47(3): 382–392. https://doi.org/10.1111/j.1365-2028.2008.00997.x

Lavigne RJ, Holland FR (1969) Comparative behavior of eleven species of Wyoming robber flies. Science Monograph University of Wyoming 18: 1–61.

Londt JGH (1994) Afrotropical Asilidae (Diptera) 25. A key to the genera of the subfamily Stenopogoninae with new synonymy and descriptions of seven new genera. Annals of the Natal Museum 35(1): 79–96. https://doi.org/10.5281/zenodo.154544

Londt JGH (2010) A taxonomic analysis of Gambian Asilidae (Diptera) based chiefly on a collection assembled by W.F. Snow between 1974 and 1977. African Entomology 18(2): 328–353. https://doi.org/10.4001/003.018.0210

Londt JGH (2013) A remarkable new genus of robber flies, *Akatiomyia* gen. n., from the Western Cape Province of South Africa, and a new key to the genera of Afrotropical Stenopogoninae (Diptera: Asilidae). African Invertebrates 54(1): 57–68. https://doi.org/10.5733/afin.054.0103

Londt JGH, Dikow T (2017) 48. Asilidae (assassin flies or robber flies). In: A.H. Kirk-Spriggs, B.J. Sinclair (Eds) Manual of Afrotropical Diptera, vol. 2. Nematocerous Diptera and lower Brachycera, 1097–1182. Suricata 5, SANBI, Pretoria.

Mittermeier RA, Myers N, Thomsen JB, da Fonseca GAB, Olivieri S (1998) Biodiversity hotspots and major tropical wilderness areas: Approaches to setting conservation priorities. Conservation Biology 12(3): 516–520. https://doi.org/10.1046/j.1523-1739.1998.012003516.x

Mittermeier RA, Gil PR, Hoffman M, Pilgrim J, Brooks TM, Mittermeier CG, Lamoreaux J, da Fonseca GAB (2005) Hotspots Revisited: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions. Conservation International, Washington, DC, 392 pp.

Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GAB, Kent J (2000) Biodiversity hotspots for conservation priorities. Nature 403(6772): 853–858. https://doi.org/10.1038/35002501

Nichols SW (1989) The Torre-Bueno Glossary of Entomology. The New York Entomological Society, New York, 840 pp.

Pyle RL, Michel E (2008) Zoobank: Developing a nomenclatural tool for unifying 250 years of biological information. Zootaxa 1950: 39–50. URL http://www.mapress.com/zootaxa/2008/f/zt01950p050. pdf

Stuckenberg BR (1999) Antennal evolution in the Brachycera (Diptera), with a reassessment of terminology relating to the flagellum. Studia Dipterologica 6(1): 33–48. https://doi.org/10.5281/zenodo.12390

Wootton RJ, Ennos AR (1989) The implications of function on the origin and homologies of the dipterous wing. Systematic Entomology 14(4): 507–520. https://doi.org/10.1111/j.1365-3113.1989.tb00300.x